

Table 2.20 (continued). Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the independent annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
Tyner	Urban	17.5	0.0	1	0	1	2
	Transportation & Utilities	21.5	0.0	2	0	2	20
	Crop	15	3.0	2	0	2	6
	Pasture/Range	11.1	118.7	3059	59	3118	5395
	Orchards & Vineyards	0	0.0	0	0	0	0
	Nurseries	0	0.0	0	0	0	0
	Forest	6.6	10.9	98	0	104	5462
	Poultry Operations	115.4	0.0	0	0	0	7
	Dairy	0	0.0	0	0	0	0
	Hog Operations	115.4	0.0	0	0	0	2
	Water	115.4	0.0	0	0	0	0
West	Urban	12.7	0.0	38	0	38	174
	Transportation & Utilities	13.4	0.2	1	0	1	15
	Crop	9.7	43.8	45	23	68	96
	Pasture/Range	6.7	119.3	7217	104	7306	14911
	Orchards & Vineyards	4.1	0.2	1	0	1	11
	Nurseries	0	0.0	0	0	0	0
	Forest	3.8	15.1	167	0	167	15148
	Poultry Operations	84.2	0.0	0	0	0	51
	Dairy	0	0.0	0	0	0	0
	Hog Operations	84.2	0.0	0	0	0	1
	Water	84.2	0.0	0	0	0	45
Caney	Urban	12	0.8	85	0	85	415
	Transportation & Utilities	13.4	0.3	3	0	3	48
	Crop	9	82.9	33	38	71	77
	Pasture/Range	6.9	95.9	3405	60	3465	11988
	Orchards & Vineyards	2.5	60.8	1	11	12	40
	Nurseries	0	0.0	0	0	0	0
	Forest	4.3	18.6	224	0	242	18640
	Poultry Operations	84.2	0.0	0	0	0	16
	Dairy	0	0.0	0	0	0	0
	Hog Operations	84.2	0.0	0	0	0	1
	Water	84.2	0.0	0	0	0	222
Bbaron	Urban	11.7	0.1	8	0	8	41
	Transportation & Utilities	14.3	0.0	2	0	2	42
	Crop	10.7	7.6	12	2	14	28
	Pasture/Range	7.7	30.5	1234	10	1249	5077
	Orchards & Vineyards	0	0.0	0	0	0	0
	Nurseries	0	0.0	0	0	0	0
	Forest	4.3	7.7	93	0	100	7725
	Poultry Operations	83.9	0.0	0	0	0	9
	Dairy	0	0	0	0	0	0
	Hog Operations	0	0.0	0	0	0	0
	Water	83.9	0.0	0	0	0	87

Table 2.20 (continued). Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the independent annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
Bilin	Urban	12.3	3.8	262	0	262	1260
	Transportation & Utilities	15	0.7	6	0	6	94
	Crop	12.5	0.3	11	0	11	19
	Pasture/Range	9	22.7	752	8	759	3777
	Orchards & Vineyards	0	0.0	0	0	0	0
	Nurseries	11.3	5.6	8	0	8	50
	Forest	4.3	4.8	58	0	58	4827
	Poultry Operations	83.9	0.0	0	0	0	1
	Dairy	0	0.0	0	0	0	0
	Hog Operations	0	0.0	0	0	0	0
Lakeup	Water	83.9	0.0	0	0	0	127
	Urban	13.6	0.0	38	0	38	167
	Transportation & Utilities	17.6	0.0	1	0	1	14
	Crop	15.8	0.3	2	0	2	2
	Pasture/Range	10.5	11.0	436	4	440	3667
	Orchards & Vineyards	7.5	2.6	3	1	4	25
	Nurseries	11.7	4.4	13	0	13	78
	Forest	5.8	2.8	23	1	24	1418
	Poultry Operations	0	0.0	0	0	0	0
	Dairy	0	0.0	0	0	0	0
Lake	Hog Operations	0	0.0	0	0	0	0
	Water	83.9	0.0	0	0	0	10
	Urban	13.2	0.0	93	0	93	419
	Transportation & Utilities	16.4	0.5	4	0	4	61
	Crop	13.2	0.0	10	0	10	16
	Pasture/Range	9.4	40.3	564	17	581	5756
	Orchards & Vineyards	3.3	18.3	5	1	6	126
	Nurseries	0	0.0	0	0	0	0
	Forest	6.7	22.6	429	0	429	22591
	Poultry Operations	0	0.0	0	0	0	0

Table 2.21. SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode.

Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
1962	101	9.1	3678	198269	626	199936
1963	64	3.2	934	72801	392	73193
1964	91	8.2	2176	275565	1906	278011
1965	97	7.8	1962	335703	1591	337717
1966	134	5.2	1554	253444	922	254475
1967	96	7.9	2345	440449	2952	442884
1968	109	8.4	2321	538846	2999	541763
1969	99	10.3	2234	754815	3407	758848
1970	102	12.1	3554	993570	4129	997793
1971	99	8.2	1915	553230	2979	556252
1972	96	11.8	2510	1039194	4504	1044713
1973	162	17.9	5302	1622049	7849	1630047
1974	127	21.0	4544	2015724	7374	2023037
1975	122	9.5	3568	973066	5117	977894
1976	83	5.5	1319	458861	2076	460586
1977	94	7.1	2323	626713	3273	630639
1978	97	8.5	2892	925148	4605	929627
1979	92	7.4	2248	752781	3587	757100
1980	64	4.3	1070	406268	2602	408889
1981	98	6.2	1696	649140	3987	653123
1982	98	11.5	3895	1964354	5806	1969842
1983	86	5.2	2533	410829	2728	413932
1984	117	11.2	3837	1648726	8306	1657534
1985	137	18.0	4363	2500151	9358	2510334
1986	121	22.3	6946	3143884	10609	3153631

Table 2.22. Unit area SIMPLE model average annual predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use.

Land Use	Runoff (cm/yr)	Sediment Yield (Mg/yr)	Soluble Phosphorus (kg/yr)	Sediment-Bound P (kg/yr)	Total Phosphorus (kg/yr)	Area (ha)
Urban	16	27	6031	5	6035	14447
Transportation & Utilities	19	3	109	0	109	1133
Crop	14	1081	9110	820	9930	3231
Pasture/Range	10	1261	990815	3524	994332	202499
Orchards & Vineyards	4	230	66	22	88	1397
Nurseries	12	11	2	0	2	148
Forest	6	182	5527	68	5629	178390
Poultry Operations	112	0	0	0	0	1385
Dairy	112	0	0	0	0	67
Hog Operations	113	0	0	0	0	180
Water	96	0	0	0	0	6744
Total	10	2795	1011659	4437	1016125	409621

Table 2.23. Sub-basin mass loading SIMPLE model average annual predictions by land use for the Upper Illinois River Basin using the continuous annual simulation mode.

Watershed Number	Watershed Name	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-Bound P (kg)	Total Phosphorus (kg)	Total Area (ha)
1	Osage	9.6	484	226510	780	227221	57350
2	Clear	9.9	136	95407	201	95633	20897
3	Fork	11.1	123	163907	9952	164156	41466
4	Flint	11.7	531	112523	732	113191	32109
5	Baron	12.3	337	156338	910	157327	39214
6	Caney	6.0	269	12528	226	12793	31447
7	Benton	9.9	159	98197	316	98513	37612
8	River	9.9	72	7809	25	7864	12563
9	Bord	8.5	256	15282	224	15506	32992
10	Tyner	8.9	131	7360	100	7473	10894
11	West	5.5	182	35263	414	32352	30452
12	Bilin	8.2	35	2421	85	2441	10155
13	Bbaron	6.3	46	3564	16	3585	13009
14	Lakeup	9.5	20	1685	0	1690	5381
15	Lake	20.3	87	3347	0	3402	34017

Table 2.24. Sub-basin unit area SIMPLE model average annual predictions by land use for the Upper Illinois River Basin using the continuous annual simulation mode.

Watershed Number	Watershed Name	Runoff (cm)	Sediment Yield (Mg/ha)	Soluble Phosphorus (kg/ha)	Sediment-Bound P (kg/ha)	Total Phosphorus (kg/ha)	Total Area (ha)
1	Osage	9.6	0.0084	3.95	0.0136	3.96	57350
2	Clear	9.9	0.0065	4.57	0.0096	4.58	20897
3	Fork	11.1	0.0030	3.95	0.2400	3.96	41466
4	Flint	11.7	0.0165	3.50	0.0228	3.53	32109
5	Baron	12.3	0.0086	3.99	0.0232	4.01	39214
6	Caney	6.0	0.0086	0.40	0.0072	0.41	31447
7	Benton	9.9	0.0042	2.61	0.0084	2.62	37612
8	River	9.9	0.0057	0.62	0.0020	0.63	12563
9	Bord	8.5	0.0077	0.46	0.0068	0.47	32992
10	Tyner	8.9	0.0120	0.68	0.0092	0.69	10894
11	West	5.5	0.0060	1.16	0.0136	1.06	30452
12	Bilin	8.2	0.0035	0.24	0.0084	0.24	10155
13	Bbaron	6.3	0.0035	0.27	0.0012	0.28	13009
14	Lakeup	9.5	0.0037	0.31	0.0000	0.31	5381
15	Lake	20.3	0.0026	0.10	0.0000	0.10	34017

Table 2.25. SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg/ha)	Soluble P (kg/ha)	Sediment- bound P (kg/ha)	Total P (kg/ha)	Area (ha)
Osage	Urban	14.2	0.002	0.25	0.00	0.25	5169
	Transportation & Utilities	17.7	0	0.07	0.00	0.07	271
	Crop	12.4	0.187	2.89	0.17	3.06	1653
	Pasture/Range	8.3	0.002	5.76	0.01	5.77	38244
	Orchards & Vineyards	3.3	0.093	0.03	0.01	0.04	679
	Nurseries	12.0	0.031	0.08	0.00	0.08	7
	Forest	4.5	0.001	0.02	0.00	0.02	10555
	Poultry Operations	112.0	0	0.00	0.00	0.00	480
	Dairy	112.0	0	0.00	0.00	0.00	42
	Hog Operations	112.0	0	0.00	0.00	0.00	73
	Water	112.0	0	0.00	0.00	0.00	177
Total							
Clear	Urban	18.5	0	0.32	0.00	0.32	4041
	Transportation	19.7	0	0.07	0.00	0.07	182
	Crop	14.5	0.217	3.08	0.16	3.24	210
	Pasture/Ra	10.2	0.003	6.66	0.01	6.67	11392
	Orchards,	4.1	0.174	0.04	0.02	0.06	164
	Nurseries	13.8	0.07	0.03	0.00	0.03	13
	Forest	6.3	0	0.02	0.00	0.02	4701
	Poultry Operations	108.8	0	0.00	0.00	0.00	115
	Hog Operations	108.8	0	0.00	0.00	0.00	4
	Water	108.8	0	0.00	0.00	0.00	75
Fork	Urban	15.3	0.001	0.26	0.00	0.26	606
	Transportation	23.3	0.002	0.07	0.00	0.07	26
	Crop	15.2	0.285	2.34	0.21	2.55	152
	Pasture/Ra	10.7	0.003	6.42	0.01	6.42	25411
	Orchards,	4.0	0.055	0.04	0.00	0.04	77
	Forest	9.0	0	0.03	0.00	0.03	14784
	Poultry Operations	108.8	0	0.00	0.00	0.00	189
	Dairy	108.8	0	0.00	0.00	0.00	4
	Hog Operations	108.8	0	0.00	0.00	0.00	18
	Water	108.8	0	0.00	0.00	0.00	199
Flint	Urban	17.5	0.001	0.28	0.00	0.28	1508
	Transportation	21.5	0.002	0.07	0.00	0.07	247
	Crop	16.3	0.718	2.86	0.45	3.31	518
	Pasture/Ra	11.4	0.006	5.70	0.02	5.73	19362
	Orchards,	4.7	0.145	0.03	0.01	0.03	143
	Forest	6.5	0.002	0.02	0.00	0.02	9892
	Poultry Operations	115.4	0	0.00	0.00	0.00	197
	Hog Operations	115.4	0	0.00	0.00	0.00	37
Water							
							205

Table 2.25 (continued). SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg/ha)	Soluble P (kg/ha)	Sediment- bound P (kg/ha)	Total P (kg/ha)	Area (ha)
Baron	Urban	19.6	0.002	0.30	0.00	0.30	169
	Transportation	24.2	0.03	0.06	0.00	0.06	8
	Crop	18.2	1.209	2.67	0.79	3.46	108
	Pasture/Ra	13.1	0.008	8.19	0.04	8.24	18976
	Orchards,	5.8	0.24	0.03	0.01	0.05	126
	Forest	10.5	0.001	0.03	0.00	0.03	19666
	Poultry Operations	123.7	0	0.00	0.00	0.00	148
	Hog Operations	123.7	0	0.00	0.00	0.00	6
	Water	123.7	0	0.00	0.00	0.00	7
Benton	Urban	15.7	0.004	0.24	0.00	0.24	278
	Transportation	19.4	0.007	0.06	0.00	0.06	78
	Crop	14.2	0.12	2.40	0.07	2.46	284
	Pasture/Ra	10.2	0.005	4.28	0.01	4.29	22703
	Orchards,	4.2	0.098	0.02	0.00	0.02	7
	Forest	6.2	0.001	0.02	0.00	0.02	13885
	Poultry Operations	113.3	0	0.00	0.00	0.00	123
	Dairy	113.3	0	0.00	0.00	0.00	18
	Hog Operations	113.3	0	0.00	0.00	0.00	29
River	Water	113.3	0	0.00	0.00	0.00	207
	Urban	17.5	0.001	0.28	0.00	0.28	101
	Transportation	21.5	0.002	0.05	0.00	0.05	17
	Crop	16.4	0.065	3.58	0.00	3.58	49
	Pasture/Ra	11.7	0.009	1.32	0.01	1.33	5669
	Forest	6.6	0.002	0.02	0.00	0.02	6629
	Poultry Operations	115.4	0	0.00	0.00	0.00	11
	Dairy	115.4	0	0.00	0.00	0.00	3
	Hog Operations	115.4	0	0.00	0.00	0.00	5
Bord	Water	115.4	0	0.00	0.00	0.00	79
	Urban	15.8	0.09	0.24	0.04	0.28	96
	Transportation	21.5	0.002	0.05	0.00	0.05	10
	Crop	18.4	0.394	1.57	0.00	1.57	13
	Pasture/Ra	11.1	0.02	1.46	0.02	1.48	10172
	Forest	6.1	0.001	0.02	0.00	0.02	22468
	Poultry Operations	115.4	0	0.00	0.00	0.00	38
	Hog Operations	115.4	0	0.00	0.00	0.00	5
	Water	115.4	0	0.00	0.00	0.00	190

Table 2.25 (continued). SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg/ha)	Soluble P (kg/ha)	Sediment- bound P (kg/ha)	Total P (kg/ha)	Area (ha)
Tyner	Urban	17.5	0.013	0.28	0.01	0.29	2
	Transportation	21.5	0.002	0.05	0.00	0.05	20
	Crop	15.0	0.495	0.49	0.00	0.49	6
	Pasture/Ra	11.1	0.022	1.34	0.02	1.36	5395
	Forest	6.6	0.002	0.02	0.00	0.02	5462
	Poultry Operations	115.4	0	0.00	0.00	0.00	7
	Hog Operations	115.4	0	0.00	0.00	0.00	2
	Water	115.4	0	0.00	0.00	0.00	0
West	Urban	12.7	0	0.23	0.00	0.23	174
	Transportation	13.4	0.011	0.04	0.00	0.04	15
	Crop	9.7	0.456	2.12	0.47	2.59	96
	Pasture/Ra	6.7	0.008	2.34	0.03	2.36	14911
	Orchards,	4.1	0.015	0.03	0.00	0.03	11
	Forest	3.8	0.001	0.01	0.00	0.01	15148
	Poultry Operations	84.2	0	0.00	0.00	0.00	51
	Hog Operations	84.2	0	0.00	0.00	0.00	1
Caney	Urban	12.0	0.002	0.21	0.00	0.21	415
	Transportation	13.4	0.006	0.05	0.00	0.05	48
	Crop	9.0	1.077	1.59	0.94	2.53	77
	Pasture/Ra	6.9	0.008	1.00	0.01	1.01	11988
	Orchards,	2.5	1.519	0.02	0.10	0.11	40
	Forest	4.3	0.001	0.01	0.00	0.01	18640
	Poultry Operations	84.2	0	0.00	0.00	0.00	16
	Hog Operations	84.2	0	0.00	0.00	0.00	1
Bbaron	Urban	11.7	0.003	0.21	0.00	0.21	41
	Transportation	14.3	0.001	0.05	0.00	0.05	42
	Crop	10.7	0.271	1.41	0.28	1.69	28
	Pasture/Ra	7.7	0.006	0.67	0.00	0.67	5077
	Forest	4.3	0.001	0.01	0.00	0.01	7725
	Poultry Operations	83.9	0	0.00	0.00	0.00	9
	Water	83.9	0	0.00	0.00	0.00	87
Bilin	Urban	12.3	0.003	0.22	0.00	0.22	1260
	Transportation	15.0	0.007	0.06	0.00	0.06	94
	Crop	12.5	0.016	3.20	0.00	3.20	19
	Pasture/Ra	9.0	0.006	0.53	0.00	0.53	3777
	Nurseries	11.3	0.111	0.04	0.00	0.04	50
	Forest	4.3	0.001	0.01	0.00	0.01	4827
	Poultry Operations	83.9	0	0.00	0.00	0.00	1
	Water	83.9	0	0.00	0.00	0.00	127

Table 2.25 (continued). SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg/ha)	Soluble P (kg/ha)	Sediment- bound P (kg/ha)	Total P (kg/ha)	Area (ha)
Lakeup	Urban	13.6	0	0.24	0.00	0.24	167
	Transportation	17.6	0.002	0.06	0.00	0.06	14
	Crop	15.8	0.16	4.08	0.24	4.32	2
	Pasture/Range	10.5	0.003	0.44	0.00	0.44	3667
	Orchards	7.5	0.103	0.08	0.02	0.10	25
	Nurseries	11.7	0.057	0.04	0.00	0.04	78
	Forest	5.8	0.002	0.02	0.00	0.02	1418
	Water	83.9	0	0.00	0.00	0.00	10
Lake	Urban	13.2	0	0.24	0.00	0.24	419
	Transportation	16.4	0.009	0.06	0.00	0.06	61
	Crop	13.2	0.002	4.16	0.00	4.16	16
	Pasture/Range	9.4	0.007	0.48	0.01	0.49	5756
	Orchards	3.3	0.145	0.01	0.00	0.01	126
	Forest	6.7	0.001	0.02	0.00	0.02	22591
	Water	93.2	0	0.00	0.00	0.00	5115

Table 2.26. Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
Osage	Urban	14.2	10	2187	0	2187	5169
	Transportation & Utilities	17.7	0	31	0	31	271
	Crop	12.4	309	4882	283	5165	1653
	Pasture/Range	8.3	76	241548	459	242007	38244
	Orchards & Vineyards	3.3	63	35	9	44	679
	Nurseries	12	0	1	0	1	7
	Forest	4.5	11	274	11	285	10555
	Poultry Operations	112	0	0	0	0	480
	Dairy	112	0	0	0	0	42
	Hog Operations	112	0	0	0	0	73
	Water	112	0	0	0	0	177
Clear	Urban	18.5	0	2134	0	2134	4041
	Transportation & Utilities	19.7	0	21	0	21	182
	Crop	14.5	46	660	33	694	210
	Pasture/Range	10.2	34	83489	148	83637	11392
	Orchards & Vineyards	4.1	29	9	4	13	164
	Nurseries	13.8	1	1	0	1	13
	Forest	6.3	0	165	0	165	4701
	Poultry Operations	108.8	0	0	0	0	115
	Dairy	0	0	0	0	0	0
	Hog Operations	108.8	0	0	0	0	4
	Water	108.8	0	0	0	0	75
Fork	Urban	15.3	1	264	0	264	606
	Transportation & Utilities	23.3	0	3	0	3	26
	Crop	15.2	43	364	33	397	152
	Pasture/Range	10.7	76	179349	229	179577	25411
	Orchards & Vineyards	4	4	4	0	4	77
	Nurseries	0	0	0	0	0	0
	Forest	9	0	680	0	695	14784
	Poultry Operations	108.8	0	0	0	0	189
	Dairy	108.8	0	0	0	0	4
	Hog Operations	108.8	0	0	0	0	18
	Water	108.8	0	0	0	0	199

Table 2.26 (continued). Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
Flint	Urban	17.5	2	709	0	709	1508
	Transportation & Utilities	21.5	0	28	0	28	247
	Crop	16.3	372	1512	238	1750	518
	Pasture/Range	11.4	116	122001	484	122466	19362
	Orchards & Vineyards	4.7	21	6	1	7	143
	Nurseries	0	0	0	0	0	0
	Forest	6.5	20	346	10	356	9892
	Poultry Operations	115.4	0	0	0	0	197
	Dairy	0	0	0	0	0	0
	Hog Operations	115.4	0	0	0	0	37
	Water	115.4	0	0	0	0	205
Baron	Urban	19.6	0	85	0	85	169
	Transportation & Utilities	24.2	0	1	0	1	8
	Crop	18.2	131	295	88	382	108
	Pasture/Range	13.1	152	165568	854	166422	18976
	Orchards & Vineyards	5.8	30	7	2	9	126
	Nurseries	0	0	0	0	0	0
	Forest	10.5	20	1003	20	1023	19666
	Poultry Operations	123.7	0	0	0	0	148
	Dairy	0	0	0	0	0	0
	Hog Operations	123.7	0	0	0	0	6
	Water	123.7	0	0	0	0	7
Benton	Urban	15.7	1	110	0	110	278
	Transportation & Utilities	19.4	1	7	0	7	78
	Crop	14.2	34	695	19	714	284
	Pasture/Range	10.2	114	109562	341	109903	22703
	Orchards & Vineyards	4.2	1	0	0	0	7
	Nurseries	0	0	0	0	0	0
	Forest	6.2	14	472	14	472	13885
	Poultry Operations	113.3	0	0	0	0	123
	Dairy	113.3	0	0	0	0	18
	Hog Operations	113.3	0	0	0	0	29
	Water	113.3	0	0	0	0	207

Table 2.26 (continued). Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
River	Urban	17.5	0	47	0	47	101
	Transportation & Utilities	21.5	0	2	0	2	17
	Crop	16.4	3	181	0	181	49
	Pasture/Range	11.7	51	8889	51	8940	5669
	Orchards & Vineyards	0	0	0	0	0	0
	Nurseries	0	0	0	0	0	0
	Forest	6.6	13	232	7	239	6629
	Poultry Operations	115.4	0	0	0	0	11
	Dairy	115.4	0	0	0	0	3
	Hog Operations	115.4	0	0	0	0	5
	Water	115.4	0	0	0	0	79
Bord	Urban	15.8	9	38	4	42	96
	Transportation & Utilities	21.5	0	1	0	1	10
	Crop	18.4	5	21	0	21	13
	Pasture/Range	11.1	203	16712	264	16976	10172
	Orchards & Vineyards	0	0	0	0	0	0
	Nurseries	0	0	0	0	0	0
	Forest	6.1	22	741	0	764	22468
	Poultry Operations	115.4	0	0	0	0	38
	Dairy	0	0	0	0	0	0
	Hog Operations	115.4	0	0	0	0	5
	Water	115.4	0	0	0	0	190
Tyner	Urban	17.5	0	1	0	1	2
	Transportation & Utilities	21.5	0	2	0	2	20
	Crop	15	3	3	0	3	6
	Pasture/Range	11.1	119	9015	124	9139	5395
	Orchards & Vineyards	0	0	0	0	0	0
	Nurseries	0	0	0	0	0	0
	Forest	6.6	11	197	5	197	5462
	Poultry Operations	115.4	0	0	0	0	7
	Dairy	0	0	0	0	0	0
	Hog Operations	115.4	0	0	0	0	2
	Water	115.4	0	0	0	0	0

Table 2.26 (continued). Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
West	Urban	12.7	0	19	0	19	174
	Transportation & Utilities	13.4	0	0	0	0	15
	Crop	9.7	44	199	44	243	96
	Pasture/Range	6.7	119	32058	343	32401	14911
	Orchards & Vineyards	4.1	0	0	0	0	11
	Nurseries	0	0	0	0	0	0
	Forest	3.8	15	76	0	76	15148
	Poultry Operations	84.2	0	0	0	0	51
	Dairy	0	0	0	0	0	0
	Hog Operations	84.2	0	0	0	0	1
	Water	84.2	0	0	0	0	45
Caney	Urban	12	0	151	0	151	415
	Transportation & Utilities	13.4	0	4	0	4	48
	Crop	9	83	125	74	199	77
	Pasture/Range	6.9	96	14074	168	14254	11988
	Orchards & Vineyards	2.5	61	1	5	6	40
	Nurseries	0	0	0	0	0	0
	Forest	4.3	19	447	0	466	18640
	Poultry Operations	84.2	0	0	0	0	16
	Dairy	0	0	0	0	0	0
	Hog Operations	84.2	0	0	0	0	1
	Water	84.2	0	0	0	0	222
Bbaron	Urban	11.7	0	3	0	3	41
	Transportation & Utilities	14.3	0	1	0	1	42
	Crop	10.7	7	38	8	46	28
	Pasture/Range	7.7	30	2589	15	2605	5077
	Orchards & Vineyards	0	0	0	0	0	0
	Nurseries	0	0	0	0	0	0
	Forest	4.3	8	31	0	31	7725
	Poultry Operations	83.9	0	0	0	0	9
	Dairy	0	0	0	0	0	0
	Hog Operations	0	0	0	0	0	0
	Water	83.9	0	0	0	0	87

Table 2.26 (continued). Mass loading SIMPLE model predictions for the Upper Illinois River Basin using the continuous annual simulation mode by land use for each watershed.

Watershed	Land Use	Runoff (cm)	Sediment Yield (Mg)	Soluble P (kg)	Sediment- bound P (kg)	Total P (kg)	Area (ha)
Bilin	Urban	12.3	4	103	0	103	1260
	Transportation & Utilities	15	1	2	0	2	94
	Crop	12.5	0	61	0	61	19
	Pasture/Range	9	23	1515	11	1526	3777
	Orchards & Vineyards	0	0	0	0	0	0
	Nurseries	11.3	6	0	0	0	50
	Forest	4.3	5	19	0	19	4827
	Poultry Operations	83.9	0	0	0	0	1
	Dairy	0	0	0	0	0	0
	Hog Operations	0	0	0	0	0	0
Lakeup	Water	83.9	0	0	0	0	127
	Urban	13.6	0	15	0	15	167
	Transportation & Utilities	17.6	0	0	0	0	14
	Crop	15.8	0	7	0	8	2
	Pasture/Range	10.5	11	1360	4	1364	3667
	Orchards & Vineyards	7.5	3	1	0	1	25
	Nurseries	11.7	4	0	0	0	78
	Forest	5.8	3	7	1	7	1418
	Poultry Operations	0	0	0	0	0	0
	Dairy	0	0	0	0	0	0
Lake	Hog Operations	0	0	0	0	0	0
	Water	83.9	0	0	0	0	10
	Urban	13.2	0	165	0	165	419
	Transportation & Utilities	16.4	1	6	0	6	61
	Crop	13.2	0	66	0	66	16
	Pasture/Range	9.4	40	3085	29	3114	5756
	Orchards & Vineyards	3.3	18	2	0	3	126
	Nurseries	0	0	0	0	0	0
	Forest	6.7	23	836	0	836	22591
	Poultry Operations	0	0	0	0	0	0

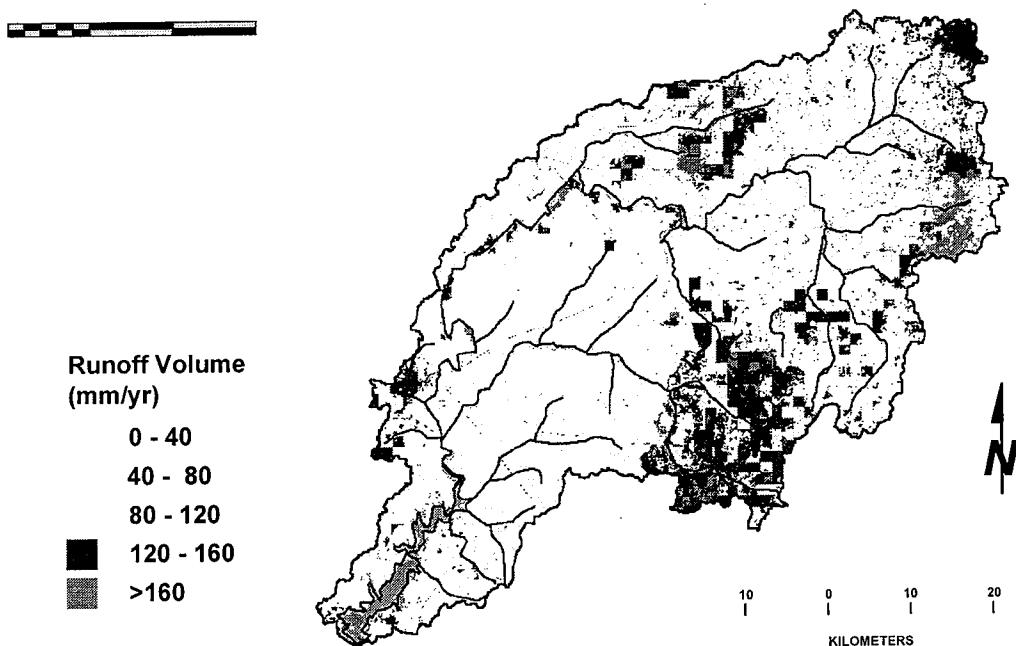


Figure 2.31. SIMPLE predicted average annual runoff volume to the Upper Illinois River basin using the independent simulation mode.

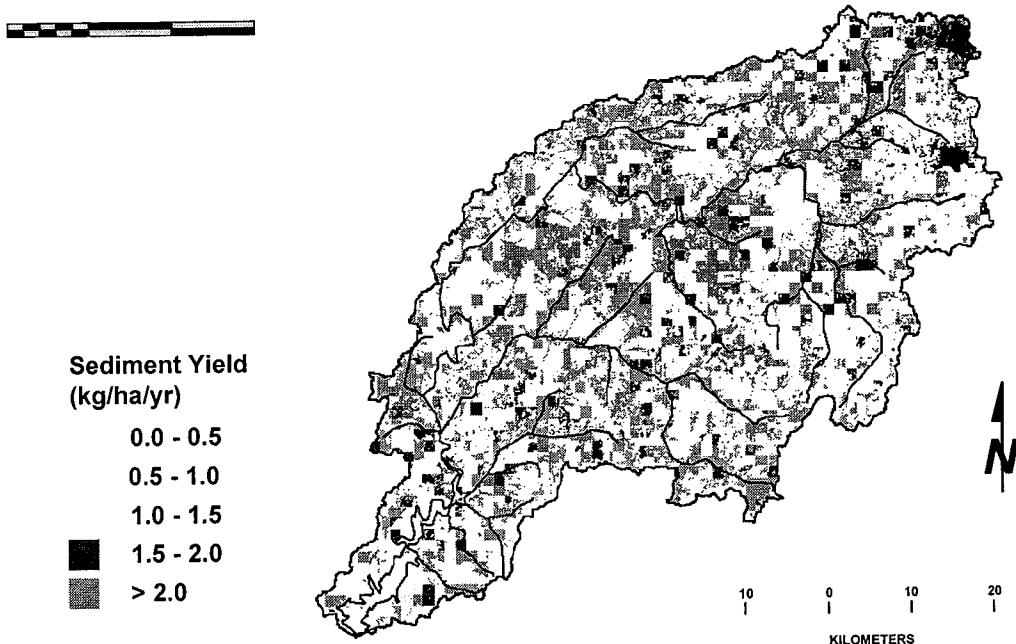


Figure 2.32. SIMPLE predicted average annual sediment load to the Upper Illinois River basin using the independent simulation mode.

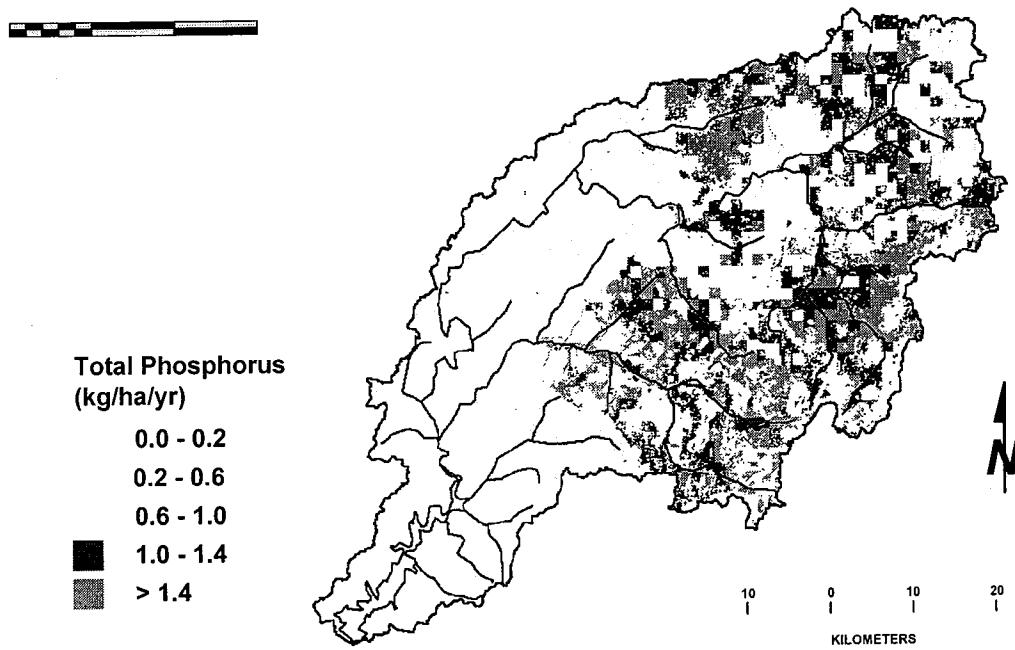


Figure 2.33. SIMPLE predicted average annual total phosphorus load to the Upper Illinois River basin using the independent simulation mode.

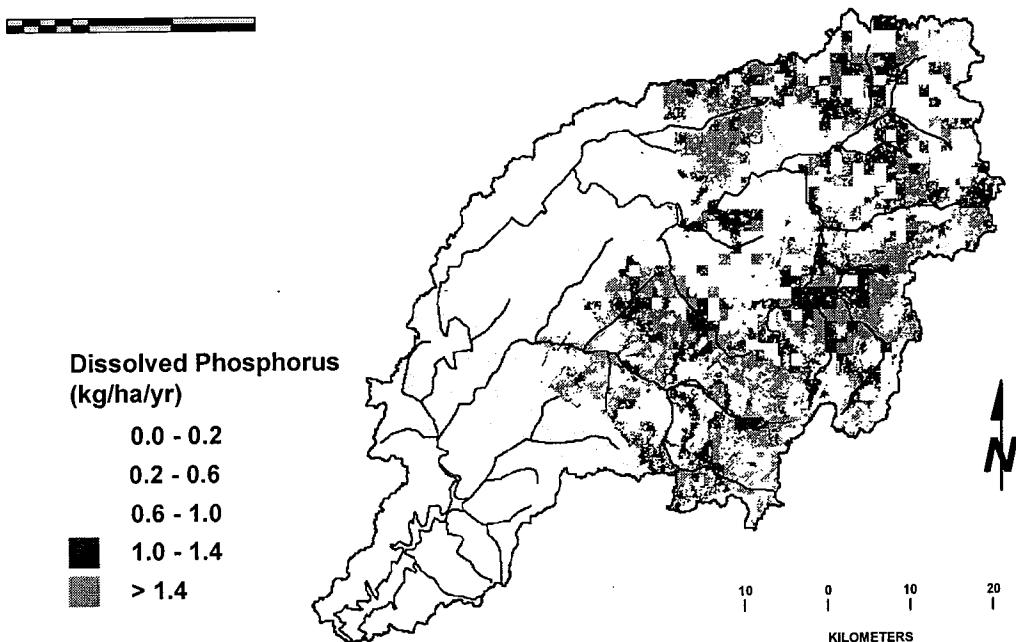


Figure 2.34. SIMPLE predicted average annual dissolved phosphorus load to the Upper Illinois River basin using the independent simulation mode.

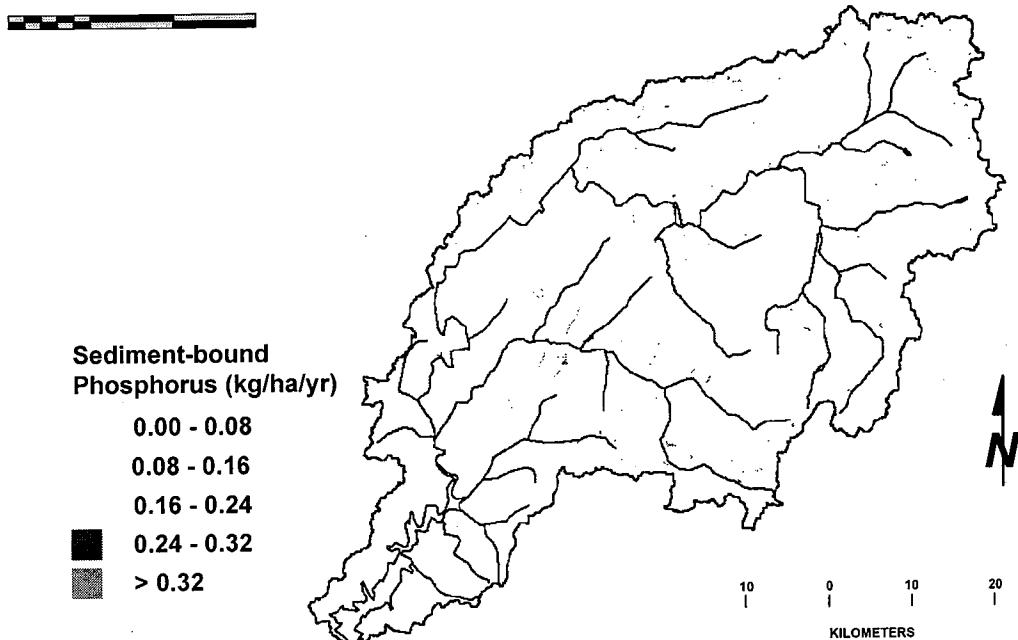


Figure 2.35. SIMPLE predicted average annual sediment-bound phosphorus load to the Upper Illinois River basin using the independent simulation mode.

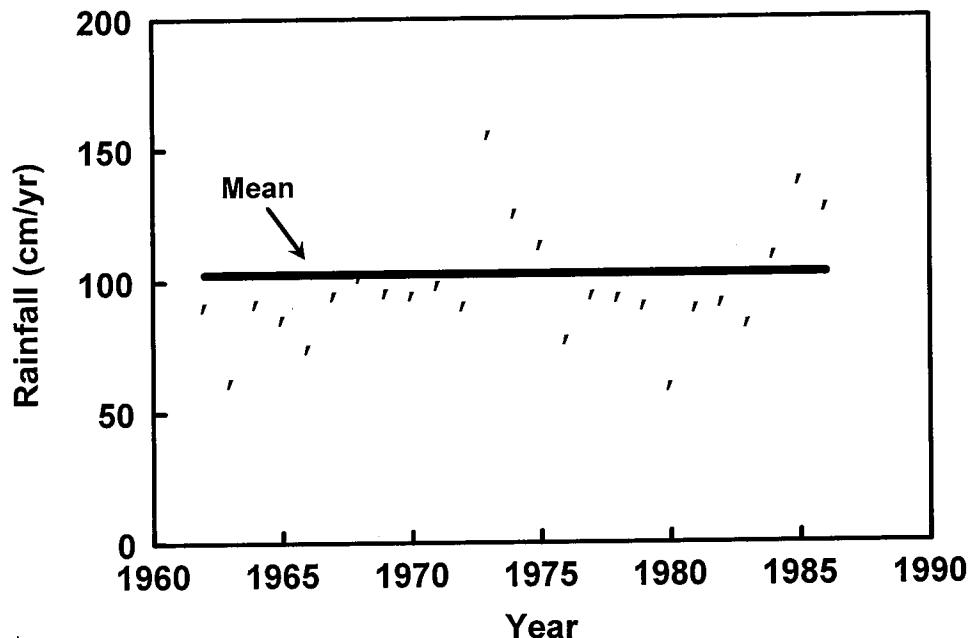


Figure 2.36. Time series of observed annual rainfall at Tahlequah, Oklahoma.

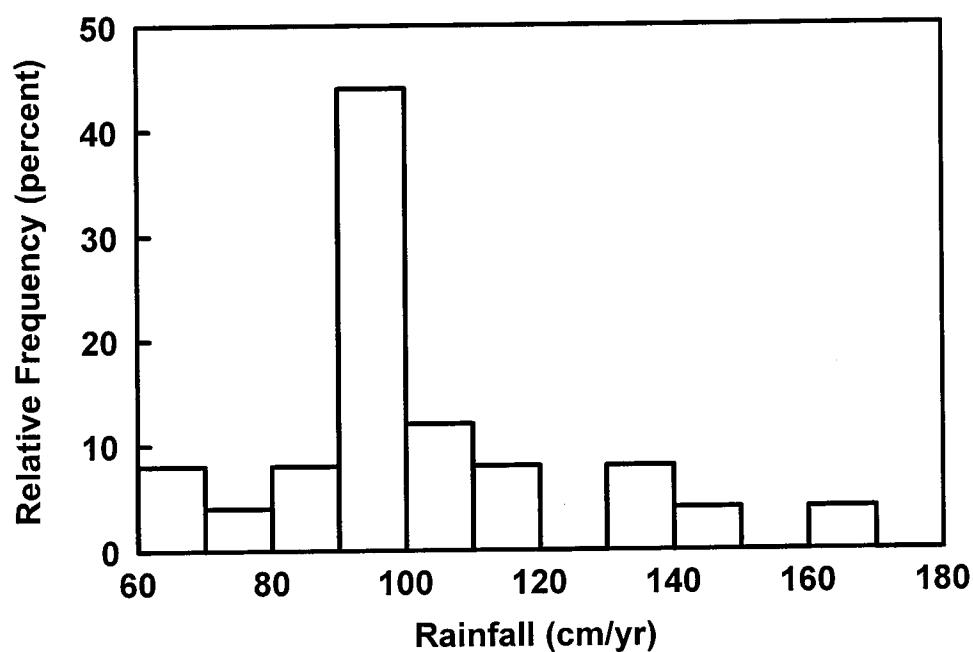


Figure 2.37. Histogram of annual observed rainfall at Tahlequah, Oklahoma.

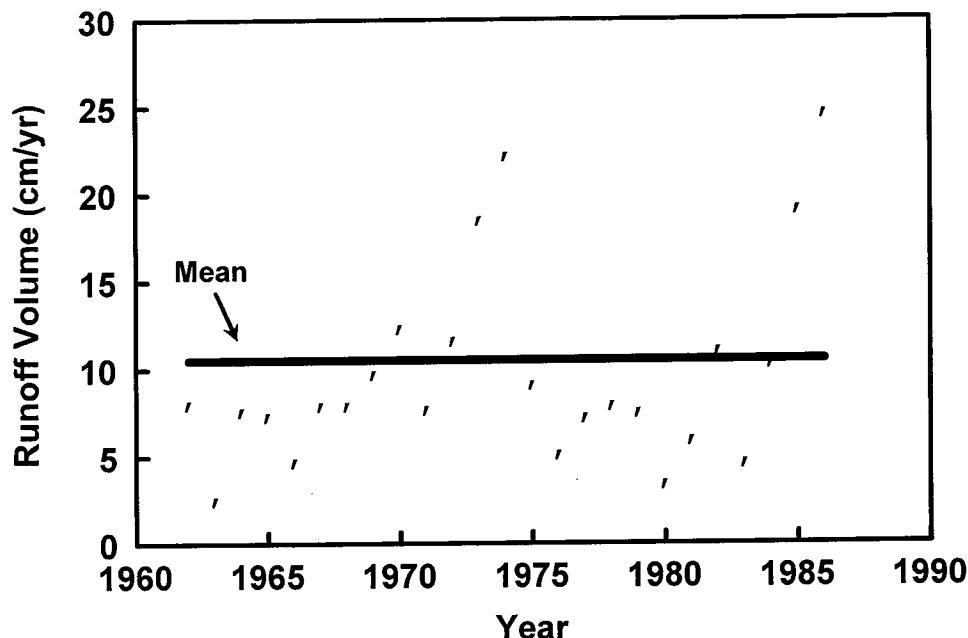


Figure 2.38. Time series of SIMPLE predicted annual runoff volume to the Upper Illinois River Basin.

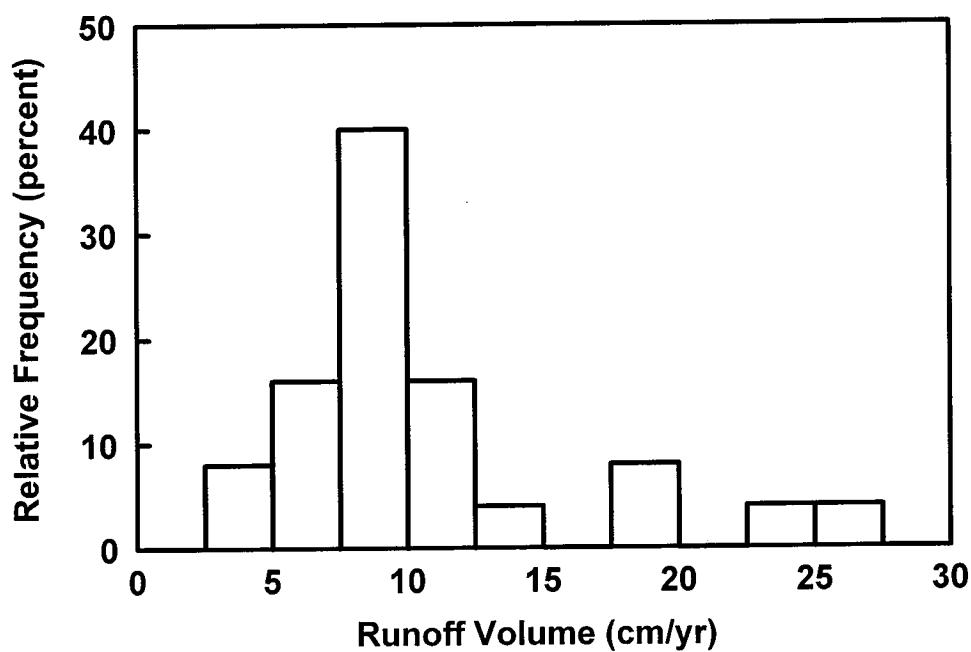


Figure 2.39. Histogram of SIMPLE predicted annual runoff volume to the Upper Illinois River Basin.

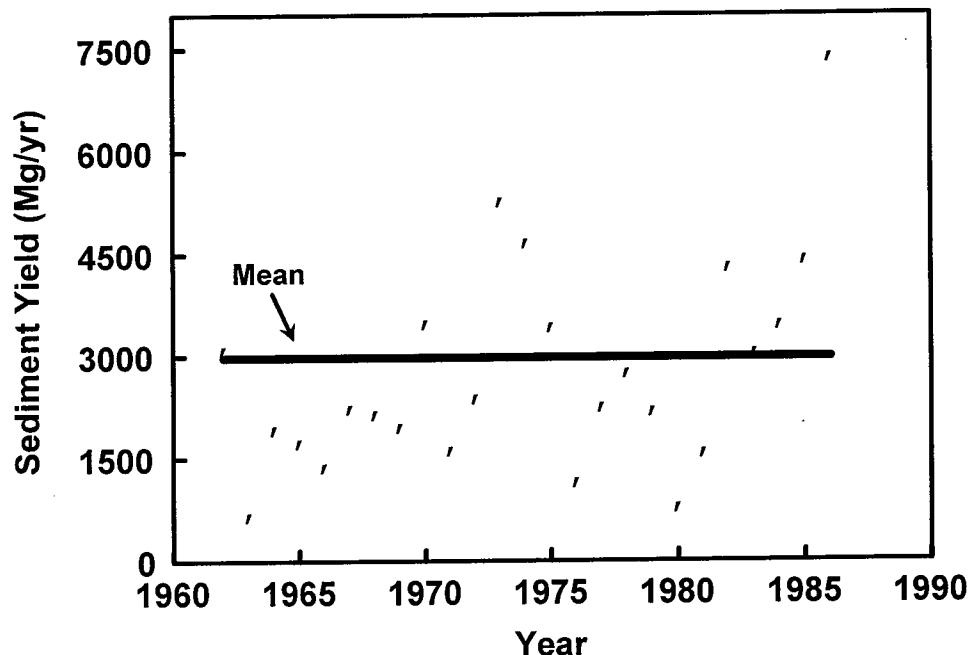


Figure 2.40. Time series of SIMPLE predicted annual sediment yield to the Upper Illinois River Basin.

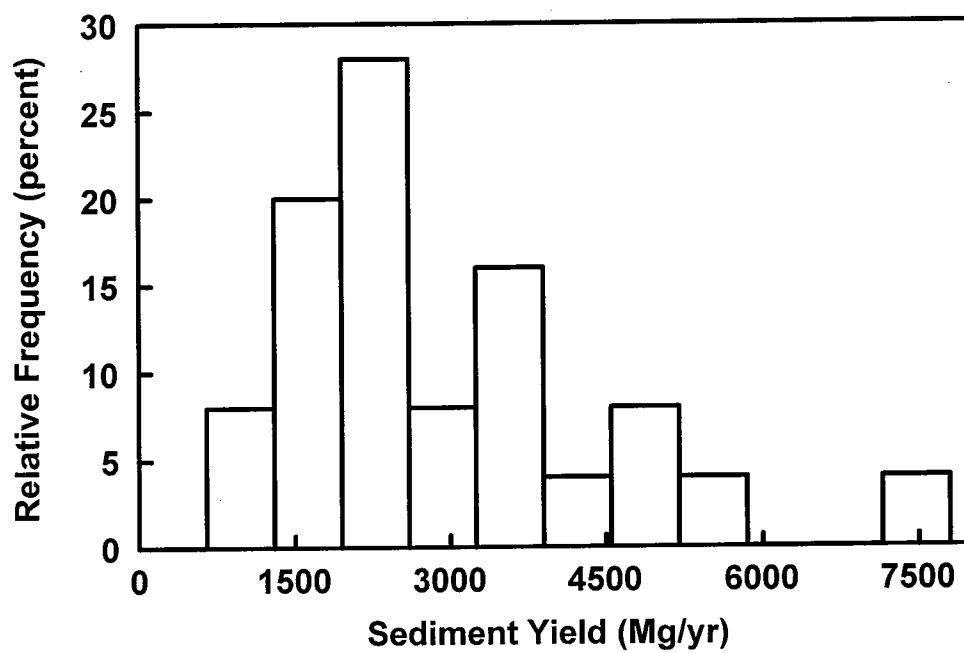


Figure 2.41. Histogram of SIMPLE predicted annual sediment yield to the Upper Illinois River Basin.

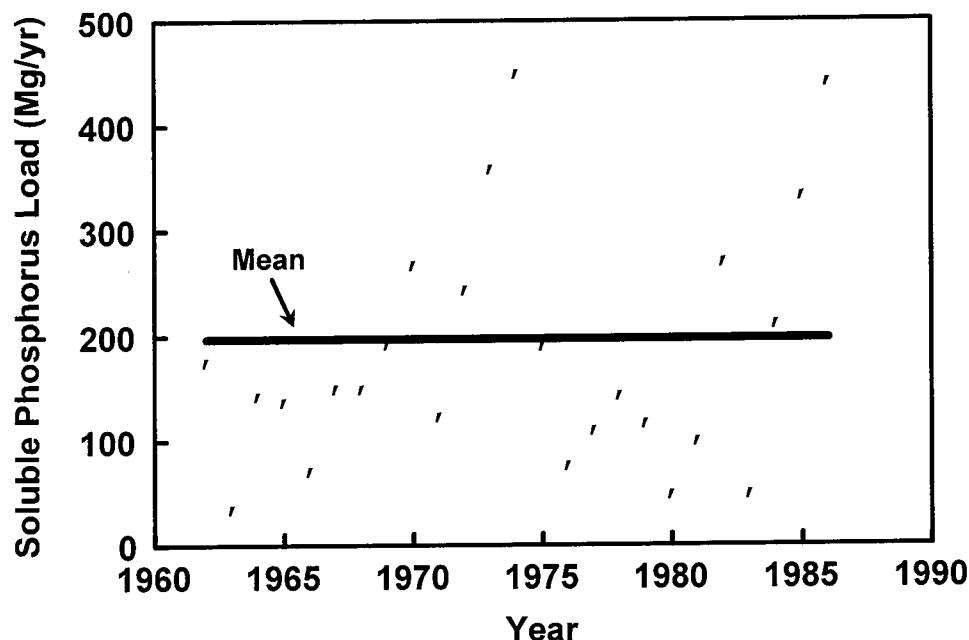


Figure 2.42. Time series of SIMPLE predicted annual soluble phosphorus load to the Upper Illinois River Basin.

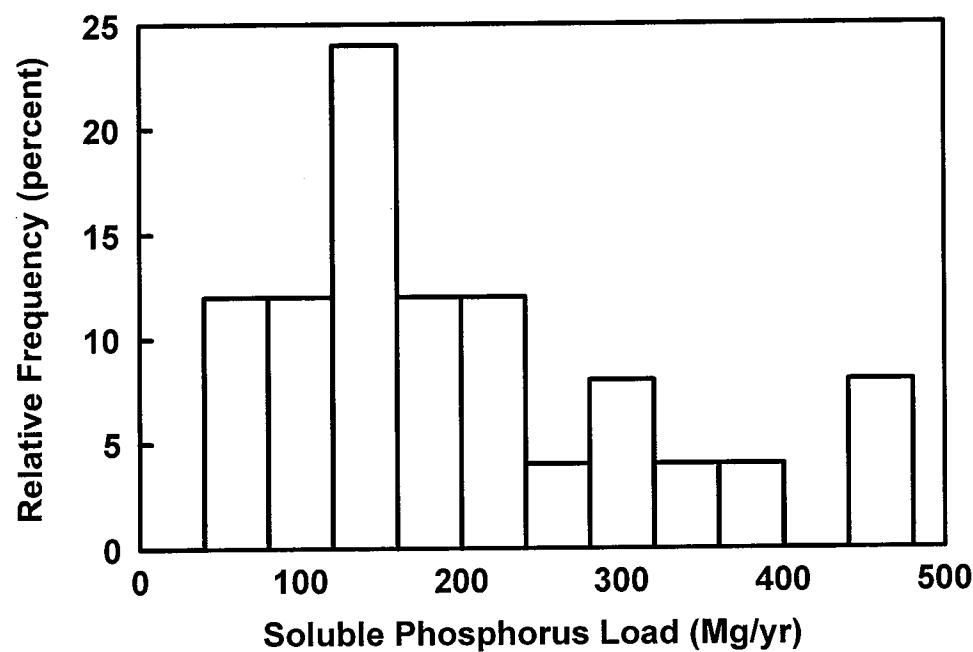


Figure 2.43. Histogram of SIMPLE predicted annual soluble phosphorus load to the Upper Illinois River Basin.

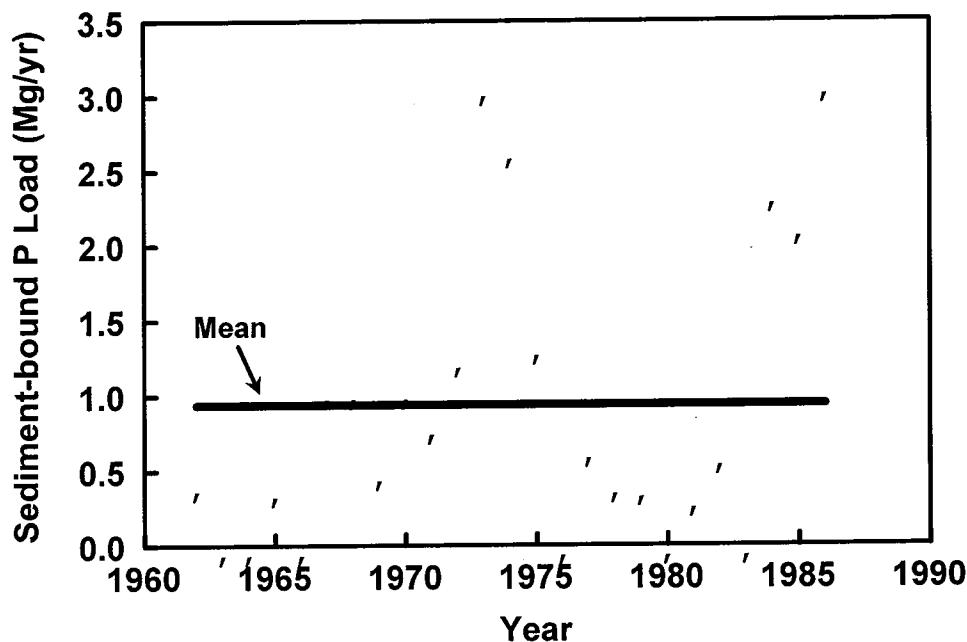


Figure 2.44. Time series of SIMPLE predicted annual sediment-bound phosphorus load to the Upper Illinois River Basin.

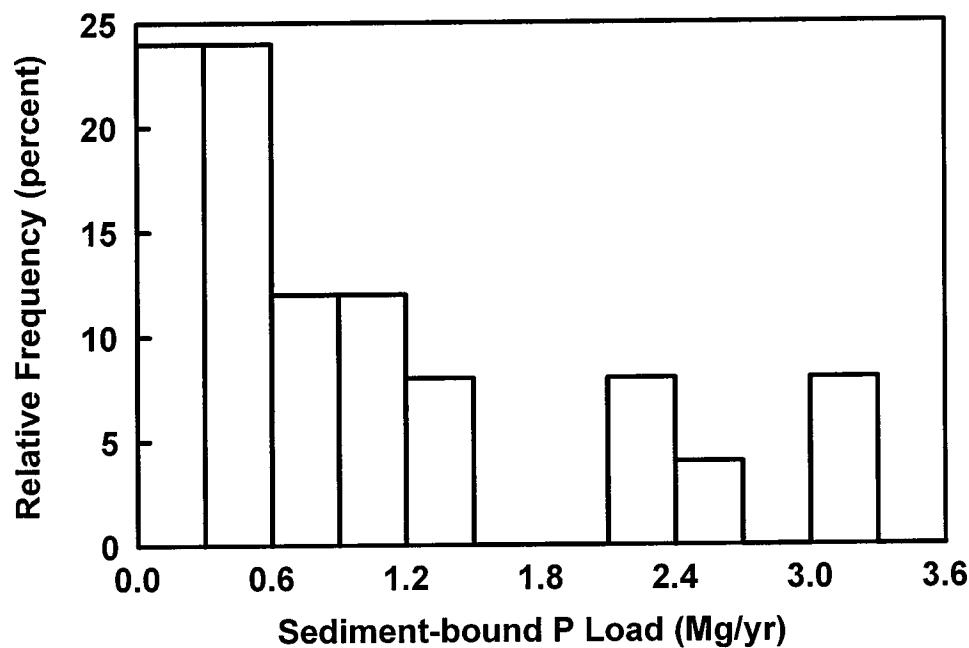


Figure 2.45. Histogram of SIMPLE predicted annual sediment-bound phosphorus load to the Upper Illinois River Basin.

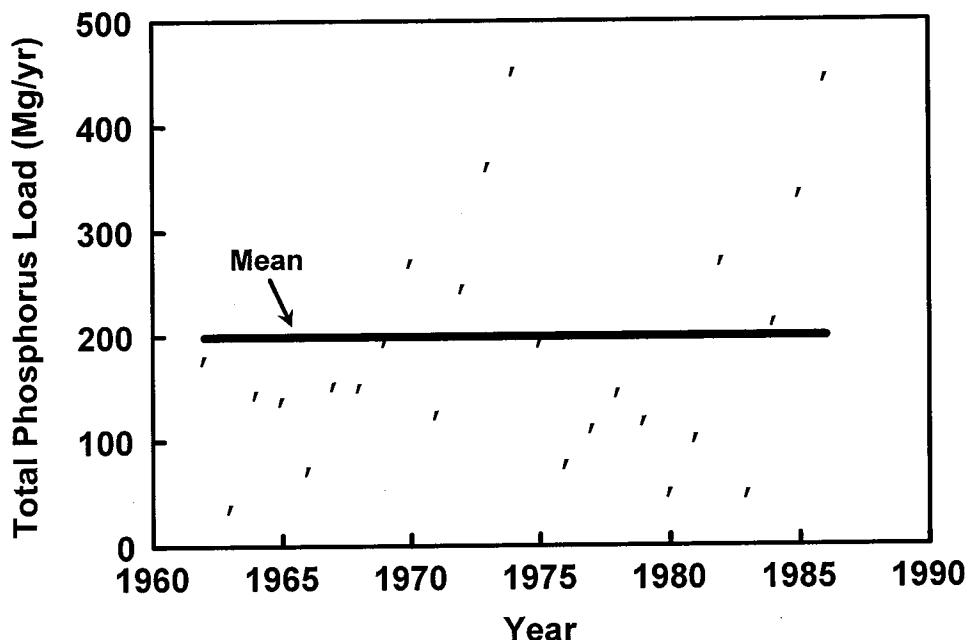


Figure 2.46. Time series of SIMPLE predicted annual total phosphorus load to the Upper Illinois River Basin.

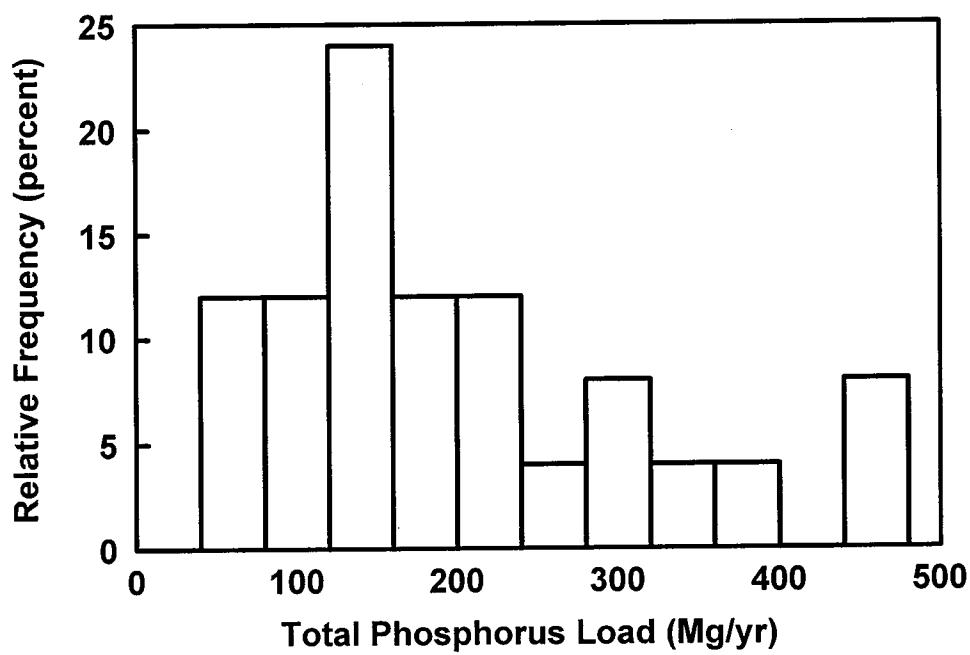


Figure 2.47. Histogram of SIMPLE predicted annual total phosphorus load to the Upper Illinois River Basin.

### CHAPTER 3. POINT SOURCE LOADING

Point source nutrient loading estimates of Lake Tenkiller are presented below. The loading estimates are extracted directly from the Cleans Lakes Project Phase I Diagnostic and Feasibility Study on Tenkiller Lake, Oklahoma. There were ten permitted point sources discharge upstream of Lake Tenkiller at Horseshoe Bend (Prairie Grove, Rogers, Fayetteville, Springdale, Lincoln, Gentry, Siloam Springs, Watts, Westville, and Midwestern Nursery), which is considered to be the beginning of the lake and represents approximately 75 percent of the Illinois River basin. There are two remaining permitted point sources that discharge downstream of Horseshoe Bend: Tahlequah, and Cherokee Nation. The estimated point source loading to the stream are given in Table 3.1. The combined total loading to the lake is estimated to be 93,000 kg P per year.

Table 3.1. Estimates of Point Source Discharge Quantities of Total Phosphorus to the Horseshoe Bend Area of Lake Tenkiller (1991 to 1993 data).

Discharger	Estimated Load at Source (kg P/yr)
Prairie Grove	1,200
Rogers	21,600
Fayetteville	4,500
Springdale	43,150
Lincoln	1,200
Gentry	1,700
Siloam Springs	10,000
Watts	500
Westville	2,900
Midwestern Nursery	600
Tahlequah	4,700
Cherokee Nation	530
Total	92,580

## CHAPTER 4. DISCUSSION AND CONCLUSIONS

### 4.1 INDEPENDENT AND CONTINUOUS NONPOINT SIMULATION MODES

Figure 4.1 shows the difference between independent simulation and continuous simulation of years in a twenty-five year historical sequence. Results are expressed as a cumulative distribution of total phosphorus loading. Both curves are continually increasing because the previous year's loadings are added to those of the year before. The difference between the two curves after 25 years of simulation, however, is significant.

The independent simulation mode (lower curve in Figure 4.1) represents the best estimator of phosphorus loading to the Illinois River based on existing conditions. Each simulation in this mode is equivalent except for weather conditions, so they reflect the weather variability of the system. Since the continuous simulation mode (upper curve in Figure 4.1) does not re-initialize parameters at the beginning of each year, accumulation of phosphorus in soils can occur. The phosphorus accumulation allows increased diffusion when there is sufficient runoff. The continuous mode, therefore, simulates the effect of continuing current management, continuing the same level of poultry production, and continuing litter application to the same fields throughout the twenty-five year period. Because the phosphorus diffusion process is not linear, the sequence of wet years and dry years can influence the loading rate. Caution must be taken when interpreting the continuous simulation results because poultry litter may not be continually spread at the same locations, and the sequence of wet and dry years may not be typical. It should be noted that the predicted runoff volumes and sediment yields are identical for both modes.

As shown in Table 4.1, the continuous simulation mode estimates a 324 percent area-weighted average increase in total phosphorus loading over the 25 year simulation period, which corresponds to an area-weighted total phosphorus loading of 0.48 and 2.30 kg/ha/yr for the independent and continuous simulation modes, respectively. Over the 25 year simulation period, the continuous simulation mode predicts a total phosphorus load 4.8 times higher than the independent simulation mode (Figure 4.1). This increase in phosphorus loading results from the continued import of nutrients into the basin in the form of feed. Since only a portion of the nutrients leave the basin in the form of finished products, such as meat, eggs and milk, there is a net accumulation of nutrients into the basin. These concepts are more thoroughly discussed by Smolen et al. (1994, 1995).

Long-term reductions of phosphorus loading can only be accomplished by exporting animal manure from the basin. Short term solutions, however, could focus on the proper or uniform distribution of poultry litter. If permanent pasture, the predominate agricultural land use in the basin, is fertilized exclusively with poultry litter based on crop needs for nitrogen, excess phosphorus is applied. Therefore, the model predicts if this practice continues over an extended period of time soil phosphorus levels will build to excessive levels and increased phosphorus loading to surface waters will result. To prevent excessive build up of soil phosphorus, litter should be diverted to fields deficient in soil phosphorus, and those fields with excessive soil phosphorus levels should discontinue use of poultry litter and receive nitrogen from commercial fertilizers.

### 4.2 POINT AND NONPOINT LOADING

Table 4.2 gives a summary of the nonpoint source mass loading from the independent simulation mode. Presented in Table 4.2 are the mean, and 25, 50 and 75 percent quartiles for total, dissolved and sediment-bound phosphorus, sediment yield, rainfall (Tahlequah, Oklahoma), and runoff volume. These quartile distributions represent the expected stochasticity of loading caused by variation in rainfall only. It does not account for parameter uncertainty. It should be noted that virtually all the predicted phosphorus loads are in the dissolved form, because upland erosion rates are low the model does not account for stream bank contributions, and in-stream biological and chemical processing of the phosphorus. The loading estimates in Table 4.2 are nonpoint source loading to the stream, and are not the loading to Lake Tenkiller since in-stream assimilation processes are neglected.

Table 4.3 presents a summary of the total loading to the Upper Illinois River basin from anthropogenic and background nonpoint sources, and point sources. Background nonpoint source loadings were estimated from SIMPLE assuming the basin was 100 percent forested. It should be noted that these background loadings are low, because they do not account for stream bank contributions and neglect contributions from the forest system other than phosphorus diffusion from soils. Anthropogenic nonpoint sources are the SIMPLE model predictions minus background loading. As shown in Table 4.3, anthropogenic and background nonpoint sources, and point sources account for 66, 2 and 32 percent of the total phosphorus loading, respectively, to the Upper Illinois River basin. Figure 4.2 shows the total phosphorus loading by pastures using the independent simulation mode.

Total phosphorus loadings are given in Table 4.1 and Figure 4.3 by sub-basin for the independent and continuous simulation modes. Based on the independent simulation mode, 76 percent of the total phosphorus load comes from six subwatersheds, Flint, Benton, Baron, Osage, Clear and Fork, although these watersheds only contain 56 percent of the basin area. The next highest unit-area total phosphorus loading is the Tyner watershed. According to these simulations, the pasture/range land use accounts for 95 percent of the total nonpoint source phosphorus loading to the basin.

#### **4.3 NONPOINT SOURCE LOADING ASSUMPTIONS AND DATA LIMITATIONS**

There are a number of assumptions that must be considered when interpreting our sediment and phosphorus loading predictions from nonpoint sources. Probably the most important and sensitive parameter in the model is the initial soil phosphorus level. Due to the lack of available data, there are several limitations to our current estimates. The soil phosphorus estimates are based on county or watershed level data, some of which were obtained outside the watersheds. Consistent site-specific data across the basin would improve the reliability of our loading estimates. In addition, it was assumed that the available soil test data accurately represented the soil phosphorus status for pastures. This assumption has not been validated, and requires additional soil testing to specifically evaluate this assumption. Our choice of minimum and maximum soil phosphorus levels and arbitrary soil phosphorus levels for all land uses except pasture and range could also be a source of error, although these were selected through professional judgment of County Extension Agents and soil scientists. Probably the most important untested assumption was that soil phosphorus levels decreased linearly with distance from poultry houses.

Another limitation of our study was the lack of current land use data. We used 1985 land use and poultry house inventories; with soil test data were from 1991 to 1995. The poultry house inventory determined the amount of litter applied to pastures in the model every April. Due to the poultry expansion since 1985 in Oklahoma, we would expect a higher density of poultry in Oklahoma increasing long-term phosphorus loadings. This would likely increase the contribution from the Oklahoma portion of the watershed. Other limitations include neglecting commercial fertilizer use, dairy, layer, pullets and turkey manure application, and human recreation inputs, all of which may be substantial.

Our current model predictions estimate sediment and phosphorus loading to the stream. We have arbitrarily defined streams to be the blue line stream from the USGS 1:24,000 Digital Line Graphs. The selection of the stream density affects the delivery ratio of sediment and sediment-bound phosphorus. It should also be noted that the delivery ratio function is an unvalidated equation, thus adding to the uncertainty of our predictions.

Another very important assumption was to neglect in-stream assimilation of nutrients and stream bank erosion, which may significantly affect our loading predictions to Lake Tenkiller. In addition, our loading estimates do not account for parameter uncertainty. They only account for weather variability, and thus caution should be taken when utilizing our loading predictions. The expected overall accuracy of the absolute sediment and phosphorus loading is relatively low due to parameter uncertainty. However, we have relatively high accuracy with the relative differences of the loadings throughout the basin.

Table 4.1 Average annual total phosphorus loading by sub-basin for independent and continuous simulation modes with percent difference calculations.

Watershed	Independent Simulation Mode		Continuous Simulation Mode		Difference Independent vs Continuous (%)
	Total Phosphorus (kg/yr)	Total Phosphorus (kg/ha/yr)	Total Phosphorus (kg/yr)	Total Phosphorus (kg/ha/yr)	
Clear	19342	0.93	95633	4.58	394
Fork	33952	0.82	164156	3.96	383
Flint	24339	0.76	113191	3.53	365
Osage	42898	0.75	227221	3.96	430
Baron	27920	0.71	157327	4.01	463
Benton	24177	0.64	98513	2.62	307
Tyner	3229	0.30	7473	0.69	131
West	7174	0.24	32352	1.06	351
River	2673	0.21	7864	0.63	194
Bord	4395	0.13	15506	0.47	253
Caney	3824	0.12	12793	0.41	235
Bilin	1101	0.11	2441	0.24	122
Bbaron	1379	0.11	3585	0.28	160
Lakeup	523	0.10	1690	0.31	223
Lake	1034	0.03	3402	0.10	229
Total	198000		943147		
Area Weighted Average		0.48		2.30	324

Table 4.2. SIMPLE predicted quartile and mean estimates of total, dissolved and sediment-bound phosphorus, sediment yield, rainfall and runoff for independent simulation mode. Note: these estimates only account for rainfall stochasticity and do not account for parameter uncertainty.

Parameter	Mean	Quartile (percent)		
		25	50	75
Total Phosphorus (kg/yr)	198,000	110,000	163,000	275,000
Dissolved Phosphorus (kg/yr)	197,000	109,000	161,000	273,000
Sediment-bound Phosphorus (kg/yr)	1,000	300	600	1,700
Sediment Yield (Mg/yr)	2,900	1,900	2,300	3,800
Rainfall (cm)	104	92	98	121
Runoff (cm)	9.9	6.2	8.4	11.8

Table 4.3. Average annual total phosphorus summary of anthropogenic and background nonpoint source loading using the independent simulation mode, and point source loading to the Upper Illinois River basin.

Source	Total Phosphorus (%)	Total Phosphorus (kg/yr)	Dissolved Phosphorus (kg/yr)	Sediment-bound Phosphorus (kg/yr)	Sediment Yield (Mg/yr)
Anthropogenic Nonpoint	66	191,000	190,000	1,000	2,500
Background	2	7,500	7,300	200	400
Point	32	93,000	---	---	---
<b>Total</b>	<b>100</b>	<b>292,000</b>	<b>191,000</b>	<b>1,200</b>	<b>2,900</b>

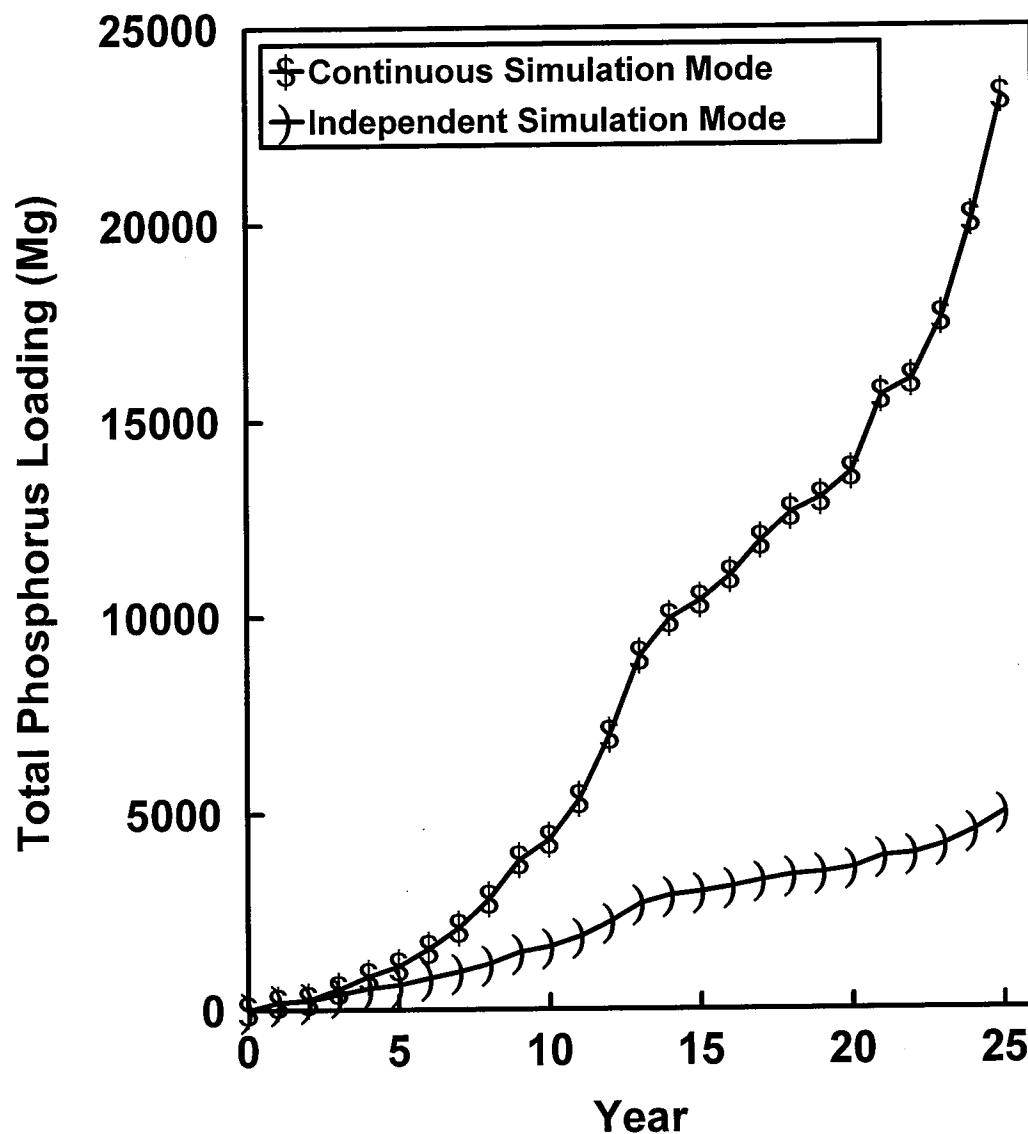


Figure 4.1. Cumulative total phosphorus loading for continuous and independent simulation modes to the Upper Illinois River basin.

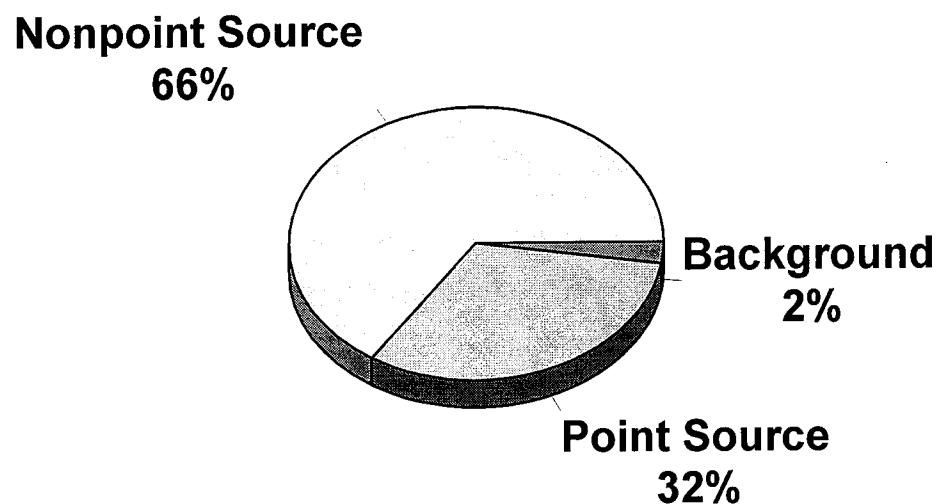


Figure 4.2. Total phosphorus summary of anthropogenic nonpoint source, background nonpoint source and point source loading to the Upper Illinois River basin.

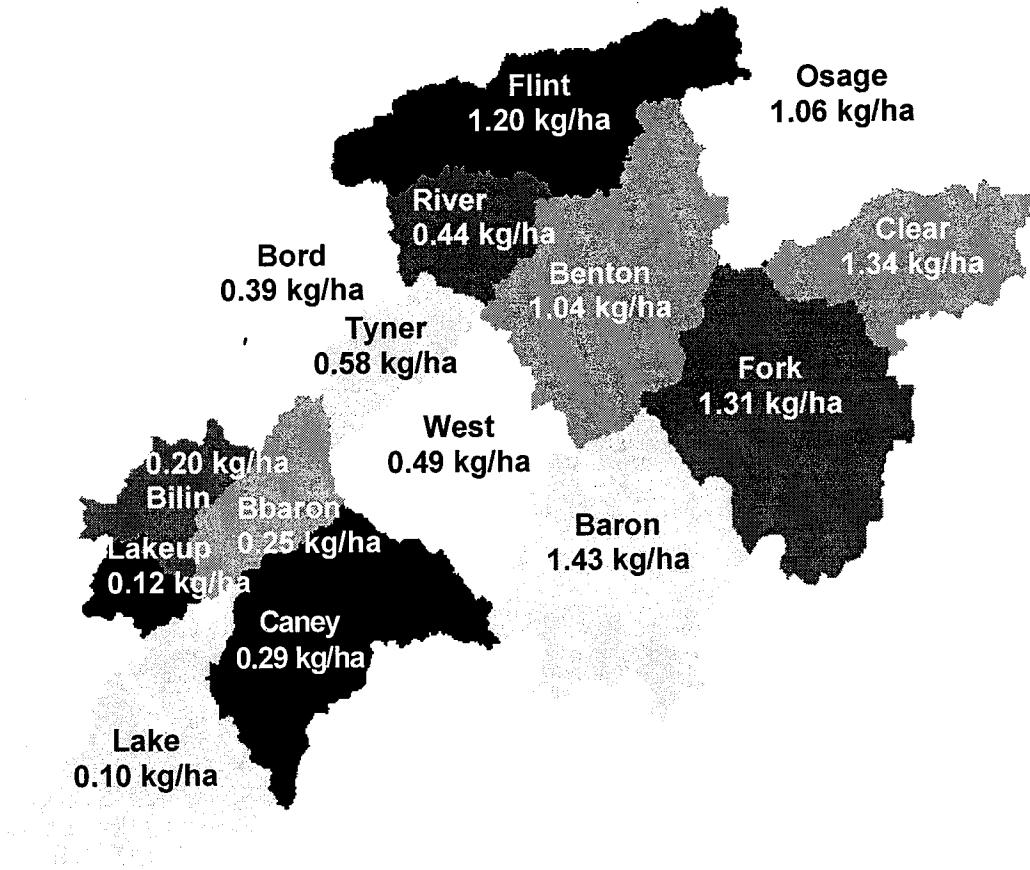


Figure 4.3. Sub-basin Average annual total phosphorus loading for pasture using the independant simulation mode for the Upper Illinois River Basin.

## REFERENCES

- Arnold, J.G., J.R. Williams, A.D. Nicks and N.B. Sammons. 1990. *SWRRB: A Basin Scale Simulation Model for Soil and Water Resources Management*. College Station: Texas A&M University Press.
- Arnold, J.G., P.M. Allen and G. Bernhardt. 1993. A comprehensive surface-ground water flow model. *J. of Hydrol.* 142(1/4):47-69.
- CERL. 1988. GRASS Reference Manual, Version 3.0. Champaign, Illinois: U. S. Army, Corps of Engineers, Construction Engineering Research Laboratory.
- Chen, Z., D.E. Storm, M.D. Smolen, C.T. Haan, M.S. Gregory, G.J. Sabbagh. 1994. Prioritizing nonpoint source loads for phosphorus with a GRASS-modeling system. *Water Resources Bulletin* 30(4):589-594
- Cooley, K.R. 1980. "Erosivity "R" for individual design storms". In CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems. U.S. Department of Agriculture, Conservation Research Report No. 36. Volume III, Chapter 2. p 386-397.
- Finley, C.D., R.K. Roberts, D.R. Raman. 1994. Production and distribution of broiler litter in Grundy, County, Tennessee. Research Report 94-17, September 1994, Department of Agricultural Economics and Rural Sociology, Agricultural Experiment Station, University of Tennessee, Knoxville, Tennessee.
- Haan, C.T. 1977. *Statistical Methods in Hydrology*. Ames: Iowa State Univ. Press.
- Heatwole, C.D., V.O. Shanholtz. 1991. "Targeting Animal Waste Pollution Potential Using a Geographic Information System." *Applied Engineering in Agriculture* 7(6):692-698.
- Hession, W.C. and V.O. Shanholtz. 1988. A geographic information system for targeting nonpoint source agricultural pollution. *J. Soil and Water Conservation* 43(3):264-
- Greenlee, D. D. 1987. "Raster and Vector Processing for Scanned Line-Work. " *Photogrammetric Engineering and Remote Sensing* 53(10):1383-1387.
- Jenson, S. K. and J. O. Domingue. 1988. "Extracting Topographic Structure from Digital Elevation Data for Geographic Information System Analysis." *Photogrammetric Engineering and Remote Sensing* 54(11):1593-1600.
- McCool, D.K., L.C. Brown, G.R. Foster, C.K. Mutchler, L.D. Meyer. 1987. "Revised slope steepness factor for the universal soil loss equation." *Transactions of the ASAE*, 30(5):1378-1395.
- McCool, D.K., G.R. Foster, C.K. Mutchler, and L.D. Meyer. 1989. Revised slope length factor for the Universal Soil Loss Equation. *Transactions of the ASAE* 32(5):1571-1576.
- Newman, A. 1995. Water pollution point sources still significant in urban areas. *Environmental Science & Technology* 29(3):114A.
- Puckett, L. J. 1995. Identifying the Major Sources of Nutrient Water Pollution. *Environmental Science & Technology* 29(9):408A-414A.
- Sabbagh, G.J., D.E. Storm, M.D. Smolen, C.T. Haan, W.C. Hession. 1995. SIMPLE: sediment and phosphorus loading model. In: WATERSHED MANAGEMENT Planning for The 21st Century. Watershed Management Committee of the Water Resources Engineering Division/ASCE, San Antonio, Texas, pp. 93-102.
- Sabbagh, G.J., D.E. Storm, C.T. Haan. 1994. Digital Terrain Model to Estimate Watershed

Characteristics for Hydrologic Modeling. International Summer Meeting of the ASAE, Paper No. 94-2034. ASAE, 2950 Niles Road, St. Joseph, Michigan, 49085-9659.

Shanholtz, V. O., C. T. Desai, N. Zhang, J. W. Kleene, C. D. Metz, and J. M. Flagg. 1990. Hydrologic/Water Quality Modeling in GIS Environment. International Summer Meeting of the ASAE, Paper No. 90-3033, ASAE, 2950 Niles Road, St. Joseph, Michigan.

Smolen, D.E., P.L. Kenkel, D.E. Storm. 1995. Nitrogen and Phosphorus Distribution in Oklahoma: A Mass Balance. In: Proceeding of the Innovations and New Horizons in Livestock and Poultry Manure Management Symposium, September 6-7, 1995, Wyndham Hotel, Austin, Texas.

Smolen, M.D., P. Kenkle, D. Peel, D.E. Storm. 1994. Mass Balance Analysis of Nutrient Flow Through Feed and Waste in the Livestock Industry in the Southern Great Plains. In: Proceedings of the Great Plains Animal Waste Conference on Confined Animal Production and Water Quality. Denver, Colorado, October 19 - 21, 1994.

Storm, D.E., G.J. Sabbagh, M.D. Smolen, M.S. Gregory, C.T. Haan. 1995. Illinois River Basin -- Treatment Prioritization. Final Report submitted to the Oklahoma Conservation Commission for the U.S. Environmental Protection Agency. Department of Biosystems and Agricultural Engineering, Oklahoma State University, Stillwater, Oklahoma.

Storm D. E. 1991. Modeling Dynamic Rill Networks from Random Surfaces on Moderate Slopes. Ph.D. Dissertation, university of Kentucky, Lexington, Kentucky.

SCS. 1978. "Predicting Rainfall Erosion Losses: A Guide to Conservation Planning". US Department of Agriculture Soil Conservation Service, Handbook No 537, Science and Education Administration, Hyattsville, MD 20782

SCS. 1985. "Hydrology." In National Engineering Handbook. Section 4. U.S. Department of Agriculture Soil Conservation Service, Washington, D.C.

Storm, D.E., T.A. Dillaha, S. Mostaghimi and V.O. Shanholtz. 1988. Modeling Phosphorus Transport in Surface Runoff. *Transactions of the ASAE* 31(1):117-127.

Wagner, R. A., T.S. Tisdale and J. Zhang 1996. A Framework for Phosphorus Transport Modeling in the Lake Okeechobee Watershed. *Water Resources Bulletin* 32(1):57-68.

Williams, J.R., C.A. Jones and P.T. Dyke. 1984. "A Modeling Approach for Determining the Relationship Between Erosion and Soil Productivity." *Transaction of ASAE* 27(1):129-144.

Wischmeier, W. H. and D.D. Smith. 1978. "Predicting Rainfall Erosion losses- A Guide to Conservation Planning." U.S. Department of Agriculture, Agriculture Handbook No. 537.

Young, R. A., C. A. Onstad, D. D. Bosch and W. P. Anderson. 1989. AGNPS: A Nonpoint-Source Pollution Model for Evaluating Agricultural Watersheds. *Journal of Soil and Water Conservation* 44(2):168-173.

## APPENDIX A

### PROCEDURE TO GENERATE FIELD BOUNDARY MAPS

A field boundary map was generated for each watershed independently. The steps and commands used to generate these maps are described in this section. Also, the source codes of the fortran utility programs used here are included at the end of this section.

a. Dividing the watershed into 225 ha grids:

This step creates an ASCII map that divide the watershed into 1500x1500 cells and then imports the map into GRASS. The ASCII map is created with the program "gensect.x" (the source code is "gensect.f"). This program reads the ASCII file "landuse.asc" and create another ascii file called "section.grd". This file is then imported into GRASS under the name "section.grd":

Commands:    gensect.x  
               r.in.ascii input=section.grd output=section.grd

b. Generate a polygon map from the land use map:

The r.clump command was applied to the land use map. A new map was created where each area of contiguous cells with the same land use values was given a unique category value. The new map was called: "tmp.clump":

Commands:    r.clump input=irb\_\$1.land use output=tmp.clump

note:    \$1 = name of the watershed  
               irb\_\$1.land use = the name of the land use map for watershed \$1

c. Limit the size of the polygons to 225 ha:

The maps "tmp.clump" and "section.grd" were intersected to create a new map with maximum polygon areas of 225 ha. This new layer was called "tmp.1":

Commands:    r.mapcalc  
               tmp.1 = if(tmp.clump, tmp.clump + section.grd \* 10000)

note:    The value 10000 was used for enumeration purposes, since the number of polygons may exceed 1000.

d. Create the field boundary map:

This part was done in two steps: (1) create an ascii representation of the file "tmp.1", and (2) re-enumerate the polygons by giving them a value from 1 to N, with N being the total number of polygons. The second step is accomplished by running the program "genfield.x". This program also allocates the same unit value to polygons that the user wants to treat as 1 field (for example, water or urban). In this study, we combined all polygons under urban were given 1 field number. The same was done for polygons under water, poultry house, hog houses and transportation.

Commands:    r.out.ascii map=tmp.1 > polygons.asc  
               genfield.x

note:    genfield.x creates an ascii representation of the field map called "field.asc". This program also creates a file called "fl\_lu.rep". This file includes a list of the field numbers and their corresponding land use numbers. "genfield.x" requires two input files: "genfield.fil" and "polygons.asc".

**A.1 FORTRAN PROGRAM "GENSECT.F"**

```

c
c Divides a region into sections with dimensions defined by the user.
c Reads the boundaries (north, south, ..) defined in the file landuse.asc
c and creates the file section.grd, which can be imported into GRASS and
c in generating the polygons needed to create the field.asc file from the
c land use data.
c
c
integer luf(5000)
integer*4 North,south,east,west
open(15,file='landuse.asc',status='old')
open(16,file='section.grd',status='unknown')
c
c .. initialize luf
totnb=5000
do 5 i=1,totnb
luf(i)=0
5      continue
c
c .. read headers from the ascii files and create headers for field.asc
read(15,7) north
read(15,7) south
read(15,8) east
read(15,8) west
7      format(t7,18)
8      format(t6,17)
c
C .. read the size of the section grid (dx,dy)
write(*,*) 'define the height of the section grid (dy)'
read(*,*) dy
write(*,*) 'define the width of the section grid (dx)'
read(*,*) dx
c
C .. determine the number of sections in each row and the number of rows,
c and adjust the SOUTH and EAST boundary values.
nsect = (north-south)/dy
dsect = (north-south)/dy
diff = nsect - dsect
if (diff.ge.0) nrow=nsect
if (diff.lt.0) nrow=nsect+1
south = north - nrow*dy
nsect = (east-west)/dx
dsect = (east-west)/dx
diff = nsect - dsect
if (diff.ge.0) ncol=nsect
if (diff.lt.0) ncol=nsect+1
east = west + ncol*dx
c
C .. Write the headers for the file section.grd
write(16,15) north
write(16,16) south
write(16,17) east
write(16,18) west
write(16,19) nrow
write(16,20) ncol
15      format('north:',i8)
16      format('south:',i8)
17      format('east:',i7)
18      format('west:',i7)
19      format('rows:',i4)
20      format('cols:',i4)
c
C .. Write the number of each section
ni=0
do 100 i=1,nrow
id=ni*ncol
write(16,30) (id+k, k=1,ncol)
FORMAT(1500I5)
30      CONTINUE
100

```

```
stop
end
```

## A.2 FORTRAN PROGRAM "GENFIELD.F"

```
cc
c program to create the ASCII file field.asc from two ascii files
c landuse.asc and polygons.asc (where polygons.asc is a cross of
c the clumped file and the section file.
c
      integer luf(5000),nids(5000),idf(5000),ids(5000),luc(5000)
      integer idl(5000), maxluid
      character*40 head, lutype(20)
      character lin1*8,lin2*113,lin3*104,lin4*62,lin5*62,lin6*64
c
      open(11,file='genfield.fil',status='old')
      open(15,file='landuse.asc',status='old')
      open(16,file='polygons.asc',status='old')
      open(17,file='field.asc',status='unknown')
      open(18,file='fl_lu.rep',status='unknown')
      open(19,file='fieldname.str',status='unknown')
      open(20,file='dat.dat.flc.asc',status='unknown')
c
c .. initialize luf and nids
c -----
      luf(m) = land use number corresponding to field m
      nids(n) = the polygon id # identified by n
      totnb=5000
      do 5 i=1,totnb
         luf(i)=0
         nids(i)=0
      5       continue
c
c .. read headers from the ascii files and create headers for field.asc
      do 10 i=1,4
         read(15,7) head
         read(16,*)
         write(17,7) head
      7       format(a15)
      10      continue
         read(15,13) head,nrow
         read(16,*)
         write(17,13) head,nrow
         read(15,13) head,ncol
         read(16,*)
         write(17,13) head,ncol
      13      format(a5,i6)
c
c .. read the land use that need to be grouped and give them field numbers
c -----
      nluc = # of land use to be grouped
      luc(m)= the land use number referenced in m
      read(11,*) nluc
      read(11,*) (luc(k),k=1,nluc)
      do 20 i=1, nluc
         luf(i)=luc(i)
      20      continue
c
c .. read the name of the land use type and the associated land use #
c -----
      maxluid = the highest land use # value
      luidn = the land use id number
      lutype (luidn) = the land use type associated with the land use number luidn
      maxluid=0
      do 30 i=1,20
         read(11,27,end=33) luidn,lutype(luidn)
      27      format(i4,a40)
                  if(luidn.gt.maxluid) maxluid=luidn
      30      continue
      33      continue
c
c .. process the information 1 row at a time
```



```

write(20,532) lin2
write(20,533) lin3
write(20,534) lin4
write(20,535) lin5
write(20,536) lin6
531      format(a8,'0')
532      format(a113)
533      format(a104)
534      format(a62)
535      format(a62)
536      format(a64)
do 550 i=1,nluc+nsec
  if(i.lt.10) write(20,541) lin1,i
  if(i.ge.10.and.i.lt.100) write(20,542) lin1,i
  if(i.ge.100.and.i.lt.1000) write(20,543) lin1,i
  if(i.ge.1000) write(20,544) lin1,i
c
  write(20,nfot) lin1,i
  write(20,532) lin2
  write(20,533) lin3
  write(20,534) lin4
  write(20,535) lin5
  write(20,536) lin6
541      format(a8,i1)
542      format(a8,i2)
543      format(a8,i3)
544      format(a8,i4)
550      continue
      write(20,*)
c
stop
end

```

### A.3 EXAMPLE for the file "GENFIELD.FIL"

```

6
1 2 8 9 10 11
1Urban
2Transportation, Communication, Utilities
3Crop
4Pasture/Range
5Orchards, Groves, and Vineyards
6Nurseries
7Forest
8Poultry Operations
9Dairy
10Hog Operations
11Water

```

**APPENDIX B**  
**SUMMARIZATION OF INPUT DATA AT FIELD SCALE**

To run SIMPLE at field scale, the input data needed to be compiled and summarized for each field. Four programs were developed to accomplish this task. These programs create files that can be imported directly into SIMPLE. These programs are described in this section. Also, a listing of their source codes and examples on the required input data files are provided in this section.

**a. genveget.x:**

This program creates the files describing the vegetation data sets. It requires two input data files: "genveget.fil" and "fl\_lu.rep". The program generates two output files:

1. "grow\_per.inp" = the dates of the growing period for each land use
2. "uslecfac.inp" = the USLE C factors associated with each land use type.

**b. genpappl.x:**

Creates the file that include the data on P management. It requires two input files: "genpappl.fil" and "fl\_lu.rep". This program creates the file "p\_applic.inp"

**c. gentopof.x:**

It reads the ascii maps describing the topographic characteristics (dist.asc, slp.asc, and slpstrm.asc) developed by DTM, and creates the file "topofile.inp"

**d. gensoilf.x:**

It reads the soil characteristics related ascii files (cn.asc, ph.asc, clay.asc, orgc.asc, initp.asc, den.asc, and k.asc) generated with the SIMPLE DATA BASE MANAGER, and generates the file "soilfile.inp".

**B.1 FORTRAN PROGRAM "GENVEGET.F"**

```

cc      -- 7/13/95 --      George J. Sabbagh
c
c Program to generate the vegetation related data sets.
c
c It reads the USLE C factors and growing period associated with
c each land use (from file genveget.fil) and generates two files
c (grow_per.inp & uslecfac.inp) that can be imported into SIMPLE.
c
c The program requires the file fl_lu.rep (land use and the associated
c field number); this file can be generated by the program genfield.x
c
c      dimension ism(20),isd(20),iem(20),ied(20),pf(20)
c      dimension iyr(20,60),id(20,60),c(20,60),luidf(3000)
c
c      open(15,file='genveget.fil',status='old')
c      open(16,file='fl_lu.rep',status='old')
c      open(17,file='grow_per.inp',status='unknown')
c      open(18,file='uslecfac.inp',status='unknown')
c
c      ism(i) = starting month of the growing period for landuse i
c      isd(i) = starting day of the growing period for landuse i
c      ied(i) = ending month of the growing period for landuse i
c      ied(i) = ending day of the growing period for landuse i
c      pf(i) = USLE practice factor for landuse i
c
c      iyr(i,j) = the year associated with landuse i
c      id(i,j) = the day associated with landuse i
c      c(i,j) = the USLE C factor for year iyr and day id for land use i.
c                  there can be 60 different
c
c      do 20 i=1,20
c          ism(i)=0
c          isd(i)=0
c          iem(i)=0

```

```

ied(i)=0
pf(i)=0
do 20 j=1,60
  iyr(i,j)=0
  id(i,j)=0
  c(i,j)=0
20  continue
c
c      nlu = the number of landuse types
read(15,*) nlu
c .. read the data associated with the growing period
do 30 i=1,nlu
  read(15,*) lu,ism(lu),isd(lu),iem(lu),ied(lu),pf(lu)
30  continue
c .. read the data associated with the C factor
do 70 i=1,nlu
  nnl=1
35  read(15,*,end=71) lu,iyrt,idt,ct
  if(lu.eq.i) then
    iyr(i,nnl) = iyrt
    id(i,nnl) = idt
    c(i,nnl) = ct
    nnl = nnl+1
  go to 35
  endif
  backspace (15)
70  continue
71  continue
c
  read(16,*)
c      idf = field number
c      luidf(idf) = landuse number associated with idf
do 73 i=1,3000
  luidf(i)=0
73  continue
nfl = 0
do 75 i=1, 3000
  read(16,*,end=76) lu,idf
  luidf(idf) = lu
  if(idf.gt.nfl) nfl=idf
75  continue
76  continue
do 100 i=1,nfl
  lu = luidf(i)
  if(lu.gt.0) write(17,81) i,ism(lu),isd(lu),iem(lu),ied(lu),pf(lu)
81  format(5(5.1x),f4.2)
  do 90 j=1,60
    if(iyr(lu,j).eq.0) go to 91
    write(18,85) i,iyr(lu,j),id(lu,j),c(lu,j)
90  format(3(5.1x),f6.4)
91  continue
100 continue
101 continue
stop
end

```

## B.2 FORTRAN PROGRAM "GENTOPOF.F"

```

Cc          -- 7/13/95 -- ..... George J. Sabbagh
Cc
c program to take cell values and generate average field values.
c it reads field.asc, and the parameter cell by cell data from the ascii files
c slp.asc, slen.asc,dist.asc and slpstrm.asc, and generates the file
c topofile.inp which can be imported directly into SIMPLE.
c NOTE: the area of the cell is taken as 0.09 ha (30m X 30m)
c
dimension fact(20)
integer*4 idf(3000),ncell(3000,20)
real avg(3000,20),sum(3000,20), par(3000,20)

```

```

character*30 filname(20)
open(12, file='topofile.inp', status='unknown')
open(15, file='field.asc', status='old')

c
read(15,*)
read(15,*)
read(15,*)
read(15,*)
read(15,5) nrow
read(15,5) ncol
5      format(t6,l10)
write(*,*) 'nrow and ncol ',nrow,ncol
c
c nbf = # of parameter fields
c filname = name of the ascii files
c fact(m) = the factor by which to multiply the values for parameter m
c cellarea = area of a cell
cellarea=0.09
nbf=4
filname(1)='slp.asc'
filname(2)='slen.asc'
filname(3)='dist.asc'
filname(4)='slpstrm.asc'
fact(1)=1
fact(2)=0.01
fact(3)=1
fact(4)=1
c
do 100 l=1, nbf
iop=i+20
open(iop,File=filname(i), status='old')
read(iop,*)
read(iop,*)
read(iop,*)
100    read(iop,*)
read(iop,*)
read(iop,*)
read(iop,*)
100    continue
do 20 J=1, 3000
idf(J)=0
do 20 mmj=1,20
sum(J,mmj)=0
par(J,mmj)=0
avg(J,mmj)=0
ncell(J,mmj)=0
20      continue
do 60 J=1, nrow
read(15,*) (idf(k), k=1, ncol)
do 60 i=1,nbf
iop=i+20
read(iop,*) (par(k,i), k=1, ncol)
do 50 k=1, ncol
if(idf(k).GT.0) then
sum(idf(k),i)=sum(idf(k),i)+par(k,i)*fact(i)
ncell(idf(k),i)=ncell(idf(k),i)+1
endif
50      continue
60      continue
do 70 i=1,nbf
do 70 k=1,3000
if(sum(k,i).GT.0) avg(k,i)=sum(k,i)/ncell(k,i)
70      continue
do 150 k=1,3000
if(ncell(k,1).GT.0) then
fielda = ncell(k,1) * cellarea
write(12,65) k,fielda,(avg(k,mm),mm=1,nbf)
65      format(l4,20(1x,f7.2))
endif
150    continue
stop
end

```

**B.3 FORTRAN PROGRAM "GENTSOILF.F"**

```

cc      -- 7/13/95 -- ..... George J. Sabbagh
cc
c program to take cell values and generate average field values.
c it reads field.asc, and the parameter cell by cell data from the ascii files
c cn.asc, k.asc, initp.asc, den.asc, orgc.asc clay.asc, and ph.asc, and
c generates the file soilfile.inp which can be imported directly into SIMPLE.
c NOTE: the area of the cell is taken as 0.09 ha (30m X 30m)
c
c      dimension fact(20)
c      integer*4 idf(3000),ncell(3000,20)
c      real avg(3000,20),sum(3000,20), par(3000,20)
c      character*30 filename(20)
c      open(12, file='soilfile.inp', status='unknown')
c      open(15, file='field.asc', status='old')
c
c      read(15,*)
c      read(15,*)
c      read(15,*)
c      read(15,*)
c      read(15,5) nrow
c      read(15,5) ncol
c      5      format(16,l10)
c      write(*,*) 'nrow and ncol ',nrow,ncol
c
c      c nbf = # of parameter fields
c      c filename = name of the ascii files
c      c fact(m) = the factor by which to multiply the values for parameter m
c      c cellarea = area of a cell
c      c lan = langmuir's option value (0 or 1)
c      c lin = linear option value (0 or 1)
c      c skd = the kd value associated with the linear option
c      cellarea=0.09
c      nbf=7
c      filename(1)='cn.asc'
c      filename(2)='k.asc'
c      filename(3)='initp.asc'
c      filename(4)='den.asc'
c      filename(5)='orgc.asc'
c      filename(6)='clay.asc'
c      filename(7)='ph.asc'
c      fact(1)=0.01
c      fact(2)=0.01
c      fact(3)=0.01
c      fact(4)=0.01
c      fact(5)=0.01
c      fact(6)=0.01
c      fact(7)=0.01
c      lan=0
c      lin=1
c      skd=175
c
c      do 100 iop=i, nbf
c          iop=i+20
c          open(iop,File=filename(i), status='old')
c          read(iop,*)
c          continue
c          100    do 20 j=1, 3000
c                  idf(j)=0
c                  do 20 mmj=1,20
c                      sum(j,mmj)=0
c                      par(j,mmj)=0
c                      avg(j,mmj)=0
c                      ncell(j,mmj)=0

```

```
20      continue
do 60 j=1, nrow
      read(15,*) (idf(k), k=1, ncol)
      do 60 i=1,nbf
          iop=i+20
          read(iop,*) (par(k,i), k=1, ncol)
      do 50 k=1, ncol
          if(idf(k).GT.0) then
              sum(idf(k),i)=sum(idf(k),i)+par(k,i)*fact(i)
              ncell(idf(k),i)=ncell(idf(k),i)+1
          endif
      50      continue
      60      continue
      do 70 i=1,nbf
          do 70 k=1,3000
              if(sum(k,i).GT.0) avg(k,i)=sum(k,i)/ncell(k,i)
      70      continue
          do 150 k=1,3000
              if(ncell(k,1).GT.0) then
                  ncn=avg(k,1)
                  write(12,65) k,ncn,(avg(k,mm),mm=2,4),lan,(avg(k,mm),mm=5,7),
                      lin,skd
      *        format(14,14,3(1x,f7.2),i3,3(1x,f7.2),i4,1x,f7.2)
              endif
      150      continue
          stop
      end
```

## APPENDIX C SUMMARIZING OUTPUT DATA

SIMPLE simulation runs generate sets of output files. The number and type of files generated is dependent on the method (cell by cell or field by field) used for conducting the simulation runs. In this project the simulations were conducted based on field by field option. The simulation results are compiled and saved in a file in "tabular" format. There are 6 output parameters in the file: runoff volume (cm), sediment loss (metric tons/ha), dissolved P (kg/ha), sediment bound P (kg/ha), and total P (kg/ha). This file includes two sets of data one for the entire watershed, and another for each field. The watershed data sets are presented by month and by year. They also summarize for the entire simulation period. The field data sets represent the total loading for the entire simulation period only.

Two types of simulation runs were conducted one in continuous mode and the other one in independent mode (see chapter 1 and 2 for definition). The SIMPLE output files for the continuous simulation were saved as \*1.ann, where \* represent the watershed name. For the independent runs, they were saved as \*2.ann.

For this project, we needed to summarize the simulation results by land use, and to develop maps describing spatially the loadings. The fortran program "sumlumap.f" and a set of shell files were written for that purpose. The shell files are mainly GRASS commands used to import the ASCII files generated by "sumlumap.f" into GRASS, and to combine the various watershed maps into 1 map for the entire basin. The program "sumlumap.fil" is presented below:

**SUMLUMAP.FOR:** This program reads the "tabular" output file generated by SIMPLE and summarize the results by land use. This program also reads the file "field.asc" and uses the field data from the simple "tabular" output file to generate 5 ASCII files representing the 5 output parameters defined above. These files describe spatially the predicted loadings associated with each of the parameters. The 5 files are: roff\_field.asc, sed\_field.asc, proff\_field.asc, psed\_field.asc and ptotol\_field.asc. It is important to note that the values presented in these ASCII files are the predicted values for the entire simulation period \* 1000. The 1000 factor was used to make these values integer so these files can be imported into GRASS. Thus, if average annual values are needed, the values in these ASCII files need to be divided by 1000\*number of years of simulation.

### C.1 FORTRAN PROGRAM "SUMLUMAP.F"

```

cc SUMLUMAP.F          9/14/95      George J. Sabbagh
c
c Program to summarize SIMPLE output such as the results are provided
c by land use. This program also reads the file field.asc and generates
c ascii files showing the spatial distribution of the simulated results
c
      Dimension areaf(2000),arealu(30),par(6,30)
      integer*2 lu(2000)
      integer*4 val(6,2000)
      character*40 strid(6),outf,filu,flarea,lusum
      character*40 lunam(30),ascfil(6)
c
      open(1,file='field.sum',status='unknown')
      open(10,file='sumlu.fil',status='old')
      read(10,*) filu,flarea,outf,lusum
      read(10,*) ntlu
      do 10 i=1,ntlu
         read(10,7) ilu,lunam(ilu)
         format(i4,a40)
    7    continue
   10   ascfil(1)='roff_field.asc'
        ascfil(2)='sed_field.asc'
        ascfil(3)='proff_field.asc'
        ascfil(4)='psed_field.asc'
        ascfil(5)='panimal_field.asc'
        ascfil(6)='ptotal_field.asc'
c

```

```

open(11,file=flu,status='old')
open(12,file=flarea,status='old')
open(13,file=outf,status='old')
open(14,file=lusum,status='unknown')

c
write(14,15)
write(14,16)
write(14,17)
write(14,18)
write(14,*)

15 format(' LAND USE',7x,'RUN',7x,'SED',11x,'P LOADING',15x,'area')
16 format(T10,'-----')
17 format(T10,'      RUN     SED     TOTAL')
18 format(T15,'cm  m ton/ha  kg p/ha  kg p/ha  kg p/ha   ha')

c
DO 20 I=1,2000
LU(I)=0
AREAF(I)=0
do 20 k=1,6
val(k,i)=0
20 CONTINUE
c
DO 30 I=1,30
AREALU(I)=0
DO 30 J=1,6
PAR(J,I)=0
30 CONTINUE
READ(11,*)
DO 100 I=1,2000
READ(11,*,END=101) LANDU,IFL
LU(IFL)=LANDU
100 CONTINUE
101 CONTINUE
do 105 i=1,2000
READ(12,*,err=106) IFL,AREAF(IFL)
LUN=LU(IFL)
AREALU(LUN)=AREALU(LUN)+AREAF(IFL)
105 continue
106 continue
c
c
DO 200 I=1,10000
READ(13,110,ERR=999) STRID(1)
FORMAT(T25,A20)
IF(STRID(1).EQ.'FIELD SUMMARY REPORT') GO TO 205
200 CONTINUE
205 READ(13,*)
READ(13,*)
READ(13,210) NBYR
210 FORMAT(T30,I3)
DO 220 K=1,8
READ(13,*)
220 CONTINUE
c
DO 250 J=1,2000
READ(13,*,END=251) I,Q,S,PQ,PS,PA,PT
LUN=LU(I)
q =q*AREAF(I)
s =s*AREAF(I)
pq=pq*AREAF(I)
ps=ps*AREAF(I)
pa=pa*AREAF(I)
pt=pt*AREAF(I)
val(1,j)=val(1,j)+q*1000
val(2,j)=val(2,j)+s*1000
val(3,j)=val(3,j)+pq*1000
val(4,j)=val(4,j)+ps*1000
val(5,j)=val(5,j)+pa*1000
val(6,j)=val(6,j)+pt*1000
PAR(1,LUN)=PAR(1,LUN)+Q/nbyr
PAR(2,LUN)=PAR(2,LUN)+S/nbyr

```

```

PAR(3,LUN)=PAR(3,LUN)+PQ/nbyr
PAR(4,LUN)=PAR(4,LUN)+PS/nbyr
PAR(5,LUN)=PAR(5,LUN)+PA/nbyr
PAR(6,LUN)=PAR(6,LUN)+PT/nbyr
c 245 write(1,245) i,iu(i),areaf(i),q,s,pq,ps,pt
      format(2i5,6(1x,f10.2))
250 CONTINUE
251 CONTINUE
C
DO 300 M=1,30
IF(AREALU(M).GT.0) THEN
  DO 290 J=1,6
    PAR(J,M)=PAR(J,M)/AREALU(M)
  CONTINUE
  WRITE(14,295) LUNAM(M),(PAR(J,M),J=1,4),PAR(6,M),arealu(m)
295  FORMAT(A10,2X,F6.2,4(2X,F8.3),2X,f8.1)
ENDIF
300 CONTINUE
c
close(11)
close(12)
close(13)
close(14)
open(11,file='field.asc',status='old')
open(12,file=ascfil(1),status='unknown')
open(13,file=ascfil(2),status='unknown')
open(14,file=ascfil(3),status='unknown')
open(15,file=ascfil(4),status='unknown')
open(16,file=ascfil(5),status='unknown')
open(17,file=ascfil(6),status='unknown')
c
read(11,330) strid(1)
read(11,330) strid(2)
read(11,330) strid(3)
read(11,330) strid(4)
330  format(a15)
read(11,331) strid(5),nrow
read(11,331) strid(6),ncol
331  format(a6,i3)
c
do 340 m=1,6
  write(m+11,330) strid(1)
  write(m+11,330) strid(2)
  write(m+11,330) strid(3)
  write(m+11,330) strid(4)
  write(m+11,331) strid(5),nrow
  write(m+11,331) strid(6),ncol
340  continue
c
do 350 m=1,3000
  lu(m)=0
350  continue
do 400 i=1,nrow
  read(11,*) (lu(m),m=1,ncol)
  do 370 j=1,6
    write(j+11,365) (val(j,lu(k)),k=1,ncol)
365  format(3000i10)
370  continue
400  continue
c
999  CONTINUE
STOP
END

```

## C.2 EXAMPLE for the file SUMLU.FIL

11	number of landuses
1Urban	landuse id number and description
2Transportation, Communication, Utilities	

3Crop  
4Pasture/Range  
5Orchards, Groves, and Vineyards  
6Nurseries  
7Forest  
8Poultry Operations  
9Dairy  
10Hog Operations  
11Water  
15,'land2a.sum'  
'osage.rep','osage.inp','osage2.ann'  
Appendix A.1  
'clear.rep','clear.inp','clear2.ann'  
'fork.rep','fork.inp','fork2.ann'  
'flint.rep','flint.inp','flint2.ann'  
'baron.rep','baron.inp','baron2.ann'  
'benton.rep','benton.inp','benton2.ann'  
'river.rep','river.inp','river2.ann'  
'bord.rep','bord.inp','bord2.ann'  
'tyner.rep','tyner.inp','tyner2.ann'  
'west.rep','west.inp','west2.ann'  
'caney.rep','caney.inp','caney2.ann'

Number of watersheds, output file name  
file names where to read the data from; \*.rep & \*.inp are described in  
and A.2; \*.ann is generated by SIMPLE

**APPENDIX D**  
**LTPLUS PROCEDURES FOR DEM DEVELOPMENT**

**A. Scanning in Data**

1. On pc next to the scanner, create a directory by using the command mkdir name.
2. Change directories to your newly created directory by using cd \new name.
3. Type ascan and press enter.
4. Set the following parameters on the screen:
  - a. Name the map. We have been using the format of three letters for the map followed by an underscore followed by the threshold setting followed by .rlc. For instance, cha\_64.rlc would tell us the name of the map, chance, the threshold setting, 64, and the output of rlc. Any naming system is acceptable.
  - b. Set density to 600 dpi.
  - c. Set output to rlc.
  - d. Set speed to 75/100.
  - e. Set X (in) to 11.0 and 22.5. These numbers are used because the scanner blurs the first couple inches of the left hand side of the scan. I moved the scanning area over 10 inches to avoid this problem. When the map is inserted into the scanner make sure that the printed part is even with the 12 inch mark. If the scanner is ever fixed, the normal numbers used is 2.0 and 21.5. Insert the map all the way over on the left hand side.
  - f. Set Y (in) to 1.0 and 28.0. The numbers used in steps e and f are for scanning in mylar quad sheets, different numbers will have to be determined for different size sheets.
  - g. To set the threshold, it will have to be determined what is the best for map you have. On the mylar maps I used 61 or 64. This will give you a starting point. A good rule of thumb to use is, the more detail you have the lower the threshold setting will have to be. What you are looking for is the point where you have the highest threshold setting and still maintain the integrity of the lines being scanned in. If the threshold setting is set to low then the lines will become intermittent. If it is set to low there will be to much interference on the map and the number of errors will increase dramatically.
  - h. Set the hysteresis to 5.
  - i. Set the dynamic to 0.
5. Insert the map. If using mylar maps, a second sheet of mylar will have to be taped to the map to prevent from scratching the original map. The orientation of the map doesn't matter because the map can be rotated any direction in LTPlus. If a sheet of mylar is used it must be down.
6. Use the mouse to click on scan.
7. After the scanner quits, click on exit.
8. Type ftp 139.78.2.48. This is biosun.
9. Type bin. This sends the information in binary.
10. Type cd /gis/u/lbryce/scan\_data/import. This will send the data to biosun. The data can be found in biosun by following this path.
11. Type put map name given in step 4a. Example: cha\_64.rlc.
12. Type bye
13. Type del \*\* It is critically important that you are in your own directory before you type this command. You could erase everything on the computer if not.

**B. Creating a Map (in 117)**

1. Start LTPlus by:
  - a. Type newgrp scan. This puts you in the group scan.
  - b. Type umask 002. This sets up the correct permissions. Steps a and b must be

typed every time LTPlus is started up or no one else will have access to the maps and the system administrator will have to set up the correct permissions.

- c. Type ltp. This starts up the LTPlus program.
2. Click on create with the mouse.
3. Name map. This step renames the map. The map should be given its' full name.
4. Click on scan input.
5. Click on import.
6. Here is a list of ways of importing data. Click on rlc.
7. Here it is asking for a reduction factor. Enter 2. This just allows the map to fit on the screen.
8. Here it is asking for the threshold. You have a choice of 1 to 4. I found that 4 worked better for me. This is another area where you will have to experiment. It is the same situation as in step 4g.
9. This is where the orientation of the map needs to be checked. If the map is backwards or upside down, use the reflect\_h or reflect\_v as needed to correct the orientation of the map.
10. Click on regis raster. This command is used to register the map. The corners of the map should be marked. Click on these corners with the middle mouse button in the order indicated by the program. This will automatically register the map.
11. Click on save.
12. Click on margin. Enter 150. This sets the margins around the map at 150 pixels.
13. Click on save.

#### C. Getting Ready to Edit

1. Click on edit0.
2. Click on contour clean 0.
3. Click on batch edit.
4. Click on thin\_lines, then type 0 and press enter, type 0 and press enter again.
5. Click on fill holes.
6. Click on thin\_lines, then type 0 and press enter, type 0 and press enter again.
7. Click on delete\_points.
8. Click on delete\_spurs, then type 5 and press enter.
9. Click on thin\_lines, then type 0 and press enter, type 0 and press enter again.
10. Click on save.

#### D. Editing

Now that we have created a map in the LTPlus program, it has to be edited. The computer has done most of the editing, but somebody has to personally complete the editing process. The purpose of editing is to have all of the lines on the contour map to be continuous and have no intersections or junctions. The job of the editor is to go to each and every junction on the map and correct the problem. Another very important function of the editor is to maintain the integrity of the map. What this means is that it is very important to keep the lines on the map exactly where they were scanned in at. Some little part of a line may have to be moved due to the inaccuracies of the scanning and creating process, but this must kept to an absolute minimum. If a line is lost during the editing process, and it will eventually happen if you edit long enough, we have a process to recover the line and put it exactly where it belongs. Do not try to put it back by drawing it in. This process will be described in detail later.

1. Click on edit0.
2. Type log clear and press enter.
3. Type log junc and press enter.
4. Click on start search and click on the map anywhere. This zooms in on the map.
5. Click on go to log +. This will take you to the first junction. There are

- several options depending on what is wrong with this junction. These are the most common commands used when editing:
- a. wink - turns on or off one pixel at a time.
  - b. connect - draws a line from a starting point to a finishing point indicated by the mouse. It also turns off all the pixels next to the drawn line.
  - c. erase\_seg - this erases the line segment that is clicked on all the way to the next junction or break in the line. Be careful!
  - d. undo - this command is both a blessing and a curse at the same time. It will return the last thing that was erased but, in order to do this it makes a block around the line and it returns everything inside the block since the last time you saved.
  - e. separate - separates lines by putting a blank space between the lines and turning on the pixels around the blank space.
  - f. bridge\_gap - used to connect lines that have a small gap in them. Especially useful for connecting lines to along the edge of the map to the border when the map has been framed.
  - g. draw line - same as connect except it doesn't turn any pixels off.
  6. Keep clicking on go to log + until all the junctions are gone. Now all the spurs have to be removed.
  7. Type frame\_map d r. This will put a frame around the map.
  8. Go along the edges of the map and ensure that all the lines are connected to the frame.
  9. Type del\_spurs 25. This removes all spurs that are 25 pixels in length.
  10. Type log clear.
  11. Type log spurs.
  12. Click on go to log +. This will take you to each of the spurs. Correct all spurs in the same manner as the junctions.
  13. Click on save.
  14. Type frame\_map e r. This will remove the frame around the map.
  15. Click on save.

#### E. Attributing

The purpose of attributing a map is to assign elevations to the contour lines on the map. This procedure isn't hard, but some experience is recommended. It is very important that the person attributing the maps be very sure of the direction that the slopes are running. The hardest part to determine are the islands. If there are any questions ask Mark or even better leave them for Mark to determine.

1. Click on special\_b1
2. Click on assemble. This converts the raster map to a vector map.
3. Click on save.
4. Click on graph\_setup. This highlights all unattributed contour lines.
5. Click on graphics\_b. This shows the vector map overlaid on the raster map.
6. Click on get\_att\_keys.
7. Now to attribute there are 3 different functions that are used:
  - a. atr\_context1 - this command allows the user to drag the mouse across the contours to label them from lower to higher elevations.
  - b. atr\_contour1 - this command allows the user to label one line at a time. This is mostly used to provide a place to start attributing from.
  - c. line\_query - this command shows the elevation of the line that is clicked on with the mouse.
8. Click on save.

#### F. Registering a Map

1. Click on scan\_input.
2. Click on regis\_geo.
3. The program is now asking if the maps are rectangular. Type yes.
4. Type width of 7.5.
5. Type height of 7.5.
6. Enter the number of the corner for which you have coordinates. Usually I had the Northeast corner coordinates which is 3.
  
7. Enter the numbers in this fashion.  
LAT            LON  
36/00/00 , 94/50/00
8. Sometimes the some of the information is automatically entered. Then only enter the information starting from step 6.

#### G. Restoring Data Lost in the Editing Process

1. Always back up the map and work with the back up only.
2. Change directory to the map directory.
3. Type ~/exchange.
4. Start LTPlus.
5. Acquire the map.
6. Type check. This is a program that shows the differences between the original scanned in map and the edited map. There will be obvious differences between the scanned map and the edited map. What you are looking for is big lines. This is usually the missing line or lines. This is also a good technique for just checking maps to see if all the lines are there.
7. Edit around the line or lines you want to keep.
8. Click on save.
9. Exit LTPlus.
10. Change to map directory.
11. Type ~/exchange2.
12. Start LTPlus.
13. Acquire map.
14. Type disprstr\_get a.
15. Type disprstr\_put.
16. Type disprstr\_get c.
17. Type disprstr\_mrg.
18. Click on save.
19. Exit LTPlus.
20. Change to map directory.
21. Type ~/exchange3.
22. Start LTPlus.
23. Acquire map.
24. Click on assemble.
25. Click on save. All lines should be back.

#### H. Comments

I have written this procedure as if a person could do it from beginning to end in one sitting. This is impossible to do. Anytime during this procedure a person can stop and save their work. All that needs to be done is to click on save and then click on exit. This takes you out of LTPlus and into the windows environment.

To pick up where you left off, all that is needed is the following:  
a. Type newgrp ( name of your group). Our group was scan.

- b. Type umask 002. This sets your correct permissions.
- c. Type ltp. This starts up the LTPlus program.
- d. Click on acquire.
- e. A list of maps will show up that belongs to you. Click on the map name that you want and the program will bring it up. Just pick up where you left off.

The next thing I want to talk about is the importance of saving your work often. Anything could happen and you could lose a lot of work. There are several commands that you could hit that will lock up the program and the only way to stop it is to kill the process. This means that all work that was done since the last time the work was saved is lost. All work should be saved at least every hour. More often if the work is complex.

The way LTPlus works is when a map is acquired it makes a copy of the original and puts it on the screen to work on. Anything can be done to this map without affecting the original map. This means that if a big mistake was made on the map on the screen everything is all right because the original is unaffected. The map can be reacquired and started on again. If the map was saved, then the LTPlus program has replaced the original map with the map on the screen and the mistake is saved forever. On the flip side, if the work is not saved often enough then work could be lost.

**APPENDIX E**  
**SIMPLE OUTPUT BY SUB-BASIN AND YEAR USING INDEPENDENT SIMULATION MODE**

E.1 Mass Loading

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
BARON	1962	101	5.6	141	13333	0	13725
	1963	70	6.2	264	14901	0	15293
	1964	106	9.0	287	21568	0	21960
	1965	115	9.6	408	22352	392	22352
	1966	98	10.8	306	14509	0	14901
	1967	126	11.1	328	26273	392	26273
	1968	140	13.2	356	30195	392	30587
	1969	122	13.2	403	29411	392	29803
	1970	155	27.3	743	64703	392	65487
	1971	118	11.5	260	26666	392	27058
	1972	110	12.5	245	30587	392	30979
	1973	207	29.5	716	65095	392	65487
	1974	157	23.3	609	54900	392	55292
	1975	134	5.0	138	11372	0	11372
	1976	115	4.1	147	7843	0	7843
	1977	106	9.9	313	17254	0	17254
	1978	111	8.7	236	18823	0	18823
	1979	115	8.3	273	19999	392	19999
	1980	88	6.0	173	14509	0	14901
	1981	111	4.0	118	9804	0	9804
	1982	125	14.9	322	32548	392	32940
	1983	102	6.5	146	15686	0	15686
	1984	161	17.2	549	40783	392	41175
	1985	151	20.5	534	43920	392	44312
	1986	146	19.1	419	44312	392	44704
BBARON	1962	65	0.6	10	0	0	0
	1963	70	4.5	25	911	0	1041
	1964	104	5.2	63	1171	0	1171
	1965	76	5.4	59	1171	0	1171
	1966	53	2.5	17	520	0	520
	1967	89	7.0	37	1561	0	1561
	1968	75	4.3	28	1041	0	1041
	1969	87	5.8	33	1171	0	1301
	1970	64	3.5	63	781	0	781
	1971	101	10.8	68	2472	0	2472
	1972	68	2.7	17	520	0	650
	1973	107	5.2	29	1171	0	1171
	1974	103	12.8	68	2732	0	2862
	1975	78	5.5	36	1171	0	1301
	1976	59	1.3	10	260	0	260
	1977	91	5.1	29	1171	0	1171
	1978	77	3.9	25	781	0	781
	1979	99	16.8	132	3512	0	3643
	1980	62	1.8	9	390	0	390
	1981	56	1.6	7	260	0	260
	1982	75	4.3	23	911	0	1041
	1983	78	2.4	15	520	0	520
	1984	81	2.4	16	520	0	520
	1985	124	12.4	79	2732	0	2732
	1986	151	29.6	251	5984	0	6114

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
BENTON	1962	121	14.3	204	36484	0	36484
	1963	59	2.6	23	6018	0	6394
	1964	103	7.6	199	19558	0	19558
	1965	94	8.6	159	18806	0	18806
	1966	103	4.3	71	8275	0	8275
	1967	109	7.4	83	18054	0	18054
	1968	129	9.0	91	21439	0	21439
	1969	111	9.5	100	21439	0	21815
	1970	115	13.1	395	34603	0	34603
	1971	101	6.6	72	16549	0	16549
	1972	106	10.9	131	28585	0	28585
	1973	193	15.7	662	37236	0	37612
	1974	153	33.6	402	84627	0	85003
	1975	152	15.4	210	39869	376	39869
	1976	97	5.4	85	11284	0	11284
	1977	98	4.2	60	9779	0	9779
	1978	93	4.0	39	8275	0	8275
	1979	104	9.7	109	24824	0	24824
	1980	65	1.1	36	1504	0	1504
	1981	114	5.5	69	13540	0	13540
	1982	101	6.9	116	16925	0	16925
	1983	88	1.1	22	752	0	752
	1984	145	16.7	238	42878	0	43254
	1985	142	12.9	149	31594	376	31594
	1986	134	20.3	261	49272	0	49648
BILIN	1962	65	1.3	6	102	0	102
	1963	70	5.8	14	812	0	812
	1964	104	7.8	72	1117	0	1117
	1965	76	7.0	49	914	0	914
	1966	53	3.4	11	406	0	406
	1967	89	9.4	26	1320	0	1320
	1968	75	6.1	16	812	0	812
	1969	87	7.4	35	1016	0	1016
	1970	64	4.8	47	609	0	609
	1971	101	14.4	38	2031	0	2031
	1972	68	4.0	37	508	0	508
	1973	107	7.7	15	1016	0	1016
	1974	103	16.0	60	2234	0	2234
	1975	78	7.5	38	1016	0	1016
	1976	59	2.0	30	203	0	203
	1977	91	7.2	45	1016	0	1016
	1978	77	5.1	17	609	0	609
	1979	99	19.6	84	2640	0	2742
	1980	62	2.7	7	305	0	305
	1981	56	2.4	6	305	0	305
	1982	75	6.2	35	812	0	812
	1983	78	3.5	9	406	0	406
	1984	81	3.8	10	406	0	406
	1985	124	15.9	51	2234	0	2234
	1986	151	34.1	122	4468	0	4570

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
BORD	1962	102	4.5	145	2309	0	2309
	1963	60	0.5	18	0	0	0
	1964	100	5.7	122	2969	0	3299
	1965	88	4.5	112	2309	0	2309
	1966	91	2.8	93	1320	0	1320
	1967	113	7.9	208	4289	0	4619
	1968	129	4.8	147	2309	0	2309
	1969	108	4.5	94	2309	0	2309
	1970	126	14.4	290	7588	0	7588
	1971	104	3.7	83	1980	0	2309
	1972	109	11.4	254	6268	0	6268
	1973	208	21.9	527	10887	330	11217
	1974	155	24.0	542	12207	330	12537
	1975	136	6.4	240	3299	0	3629
	1976	101	6.0	108	2639	0	2639
	1977	127	8.8	220	4619	0	4619
	1978	108	6.9	255	3629	0	3629
	1979	99	3.9	197	1980	0	1980
	1980	61	1.6	37	660	0	660
	1981	119	8.0	191	3959	0	4289
	1982	89	4.1	515	1980	0	1980
	1983	98	3.1	538	1320	0	1650
	1984	126	7.0	151	3959	0	3959
	1985	183	17.7	424	9238	330	9568
	1986	142	27.8	879	12537	330	12867
CANEY	1962	89	9.8	594	5975	0	6289
	1963	105	5.1	220	2830	0	3145
	1964	85	8.8	292	5660	0	5660
	1965	87	6.2	199	3774	0	3774
	1966	67	0.8	76	314	0	314
	1967	89	4.1	292	2516	0	2830
	1968	60	4.8	191	2830	0	3145
	1969	80	8.3	303	5346	0	5660
	1970	63	2.3	116	1258	0	1258
	1971	126	12.4	390	8176	314	8176
	1972	94	7.8	310	4717	0	5032
	1973	115	9.1	340	5660	314	5975
	1974	101	4.8	245	3145	0	3145
	1975	115	4.5	280	2830	0	2830
	1976	64	2.2	88	1258	0	1258
	1977	58	1.1	82	629	0	629
	1978	109	10.9	530	6604	314	6918
	1979	67	4.4	208	2830	0	2830
	1980	55	7.2	251	4717	0	4717
	1981	68	2.3	128	1258	0	1258
	1982	88	4.3	272	2516	0	2516
	1983	73	3.7	130	2201	0	2201
	1984	91	11.9	660	7547	314	7862
	1985	81	4.4	221	2830	0	2830
	1986	74	8.0	310	5346	0	5346

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
CLEAR	1962	122	13.6	167	28002	0	28211
	1963	55	3.4	41	6896	0	6896
	1964	92	7.4	99	15046	0	15255
	1965	101	6.7	61	12956	0	12956
	1966	95	8.6	146	11284	0	11284
	1967	98	8.1	118	16300	0	16509
	1968	124	6.6	143	12329	0	12538
	1969	112	16.9	170	30928	0	31137
	1970	106	9.0	91	18389	0	18389
	1971	89	4.9	73	9404	0	9404
	1972	104	15.8	180	32808	209	33017
	1973	165	14.6	240	29674	209	29674
	1974	134	17.7	177	34898	209	34898
	1975	124	7.0	194	12956	0	12956
	1976	79	3.5	64	5224	0	5224
	1977	103	5.5	86	9613	0	9613
	1978	109	10.5	131	20270	0	20479
	1979	95	2.0	43	2926	0	2926
	1980	71	2.6	40	5015	0	5015
	1981	114	6.4	80	12747	0	12747
	1982	138	30.2	408	61019	209	61228
	1983	91	4.0	34	7523	0	7732
	1984	127	7.2	205	14210	0	14210
	1985	135	15.2	177	28838	0	29047
	1986	133	20.7	238	42003	209	42212
FLINT	1962	102	6.8	412	12844	321	13165
	1963	60	0.9	70	321	0	321
	1964	100	8.8	319	17981	0	17981
	1965	88	6.8	282	13486	0	13486
	1966	91	4.7	240	8348	0	8348
	1967	113	11.5	429	24724	321	25045
	1968	129	8.0	415	13165	321	13486
	1969	108	6.8	254	12844	0	13165
	1970	126	19.0	631	42063	321	42384
	1971	104	6.2	245	12201	0	12523
	1972	109	15.7	514	34678	321	34999
	1973	208	29.6	1230	60365	642	60686
	1974	155	30.6	937	68071	321	68392
	1975	136	9.8	683	19908	321	20229
	1976	101	8.5	221	14770	0	14770
	1977	127	12.5	608	26008	321	26329
	1978	108	10.0	335	19265	0	19586
	1979	99	5.6	300	10596	0	10917
	1980	61	2.6	112	4495	0	4816
	1981	119	10.8	441	22797	321	23118
	1982	89	6.2	454	11238	0	11559
	1983	98	4.8	486	8348	0	8348
	1984	126	10.4	421	22155	321	22476
	1985	183	24.8	966	52980	321	53622
	1986	142	32.2	2263	68071	642	68713

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
FORK	1962	122	15.1	137	49345	0	49345
	1963	55	3.9	30	12440	0	12440
	1964	92	8.4	85	26538	0	26953
	1965	101	7.6	56	22806	0	22806
	1966	95	9.6	118	19904	0	19904
	1967	98	9.1	166	29026	0	29026
	1968	124	7.8	123	22392	0	22392
	1969	112	18.9	118	54735	0	54735
	1970	106	10.4	66	32758	0	32758
	1971	89	5.4	37	16172	0	16172
	1972	104	17.3	152	57223	0	57223
	1973	166	16.6	164	52247	0	52247
	1974	134	19.8	150	61370	0	61370
	1975	124	8.1	170	22806	0	23221
	1976	79	4.0	65	9123	0	9123
	1977	103	6.4	82	17001	0	17001
	1978	109	11.8	95	36075	0	36075
	1979	95	2.5	55	5391	0	5391
	1980	71	3.1	56	8708	0	9123
	1981	114	7.4	64	22392	0	22806
	1982	138	32.5	355	105324	0	105738
	1983	91	4.6	29	13684	0	13684
	1984	127	8.4	344	25294	0	25294
	1985	135	17.0	170	51003	0	51003
	1986	133	22.6	199	72980	0	72980
LAKE	1962	78	15.2	38	680	0	680
	1963	50	8.8	11	340	0	340
	1964	83	16.1	46	680	0	680
	1965	80	13.6	32	340	0	340
	1966	62	9.5	8	0	0	0
	1967	84	14.3	64	340	0	340
	1968	89	16.6	40	680	0	680
	1969	87	20.0	87	1021	0	1021
	1970	70	13.6	47	680	0	680
	1971	93	20.5	72	1021	0	1021
	1972	91	21.2	63	1361	0	1361
	1973	124	24.7	73	1021	0	1021
	1974	128	37.5	200	2721	0	2721
	1975	101	17.8	193	340	0	340
	1976	73	15.4	67	680	0	680
	1977	95	18.8	36	680	0	680
	1978	76	13.4	20	340	0	340
	1979	102	23.2	86	1361	0	1361
	1980	74	13.7	27	340	0	340
	1981	84	15.5	32	340	0	340
	1982	91	17.9	109	680	0	680
	1983	102	25.6	229	1701	0	1701
	1984	98	17.0	132	340	0	340
	1985	168	50.8	247	4082	0	4082
	1986	143	47.3	209	4082	0	4082

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
LAKEUP	1962	65	1.0	4	54	0	54
	1963	69	6.6	8	377	0	377
	1964	103	9.4	21	538	0	538
	1965	76	7.9	18	430	0	430
	1966	53	3.7	7	215	0	215
	1967	88	11.3	16	646	0	646
	1968	75	7.3	9	430	0	430
	1969	86	8.2	19	430	0	484
	1970	64	5.6	22	269	0	269
	1971	101	17.8	25	969	0	969
	1972	68	4.5	12	269	0	269
	1973	106	9.3	9	484	0	484
	1974	103	18.9	24	1022	0	1022
	1975	78	9.0	20	484	0	484
	1976	59	1.9	47	108	0	108
	1977	91	8.5	19	484	0	484
	1978	76	5.5	9	323	0	323
	1979	98	22.5	60	1238	0	1238
	1980	62	3.0	4	161	0	161
OSAGE	1981	56	2.5	4	161	0	161
	1982	74	7.4	14	430	0	430
	1983	78	3.5	4	215	0	215
	1984	81	4.3	6	215	0	215
	1985	124	19.0	69	1022	0	1022
	1986	151	38.9	51	2045	0	2045
OSAGE	1962	120	7.6	1052	33837	0	33837
	1963	57	1.1	67	1721	0	1721
	1964	95	7.5	298	31543	0	31543
	1965	114	11.6	329	43586	0	43586
	1966	85	4.7	317	15485	0	16058
	1967	93	5.9	323	24661	0	25234
	1968	143	11.8	547	48174	0	48174
	1969	114	8.8	361	37278	0	37278
	1970	125	11.8	740	56777	0	57350
	1971	102	6.4	243	28675	0	28675
	1972	98	8.4	226	40145	0	40145
	1973	184	15.9	708	71688	574	72261
	1974	122	20.6	553	105524	574	106098
	1975	145	17.4	993	80864	574	81437
	1976	90	6.4	243	27528	0	28102
	1977	98	5.0	525	20646	0	20646
	1978	105	6.5	654	26955	0	26955
	1979	108	10.5	391	48748	0	49321
	1980	73	3.7	137	15485	0	15485
	1981	110	3.9	341	13191	0	13764
	1982	102	9.2	494	43013	0	43013
	1983	92	1.9	270	3441	0	3441
	1984	137	12.3	596	55056	574	55056
	1985	152	19.6	826	86025	574	86599
	1986	134	22.6	875	106098	574	106671

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
RIVER	1962	101	5.4	34	1382	0	1508
	1963	60	0.5	7	0	0	0
	1964	99	7.0	32	2010	0	2010
	1965	88	5.5	25	1508	0	1508
	1966	91	3.5	24	879	0	879
	1967	113	9.5	54	2638	0	2764
	1968	129	6.0	36	1508	0	1508
	1969	108	5.3	23	1382	0	1382
	1970	125	16.5	77	4523	0	4648
	1971	104	4.7	24	1382	0	1382
	1972	109	13.4	63	3769	0	3769
	1973	208	25.4	134	6658	126	6784
	1974	155	27.1	159	7412	126	7412
	1975	136	7.8	67	2136	0	2261
	1976	101	7.0	27	1759	0	1759
	1977	127	10.4	54	2889	0	2889
	1978	108	8.2	75	2136	0	2261
	1979	99	4.5	62	1131	0	1131
	1980	60	1.9	10	503	0	503
	1981	119	9.1	47	2513	0	2513
	1982	89	5.0	184	1256	0	1256
	1983	98	3.7	182	879	0	879
	1984	126	8.4	38	2387	0	2387
	1985	182	21.0	109	5779	126	5905
	1986	142	29.9	244	7412	126	7538
TYNER	1962	101	4.6	59	1743	0	1743
	1963	60	0.1	7	0	0	0
	1964	99	6.2	57	2397	0	2397
	1965	88	4.7	49	1743	0	1852
	1966	91	2.7	45	1089	0	1089
	1967	113	8.5	95	3159	109	3268
	1968	128	4.9	66	1852	109	1852
	1969	108	4.5	44	1634	0	1743
	1970	125	15.5	135	5447	109	5556
	1971	104	3.8	41	1525	0	1634
	1972	109	12.5	121	4575	109	4575
	1973	207	23.6	238	8062	109	8171
	1974	155	25.9	255	8824	109	8933
	1975	136	6.6	118	2506	109	2615
	1976	101	6.2	52	2070	0	2179
	1977	127	9.4	102	3377	109	3486
	1978	108	7.3	147	2615	0	2724
	1979	99	3.8	122	1416	0	1416
	1980	60	1.5	17	545	0	654
	1981	119	8.2	86	2941	0	3050
	1982	89	4.2	364	1525	0	1525
	1983	98	2.9	362	1089	0	1089
	1984	126	7.4	75	2832	109	2832
	1985	182	19.4	205	6972	109	7081
	1986	142	28.9	420	9042	109	9260

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
WEST	1962	89	9.4	674	12181	305	12485
	1963	105	4.5	129	5481	0	5786
	1964	85	8.4	184	11267	0	11572
	1965	87	5.7	125	7613	0	7918
	1966	67	0.5	75	609	0	609
	1967	89	3.6	107	5481	0	5481
	1968	60	4.5	113	5786	0	6090
	1969	80	7.9	190	10963	305	10963
	1970	63	2.0	92	2741	0	2741
	1971	126	11.8	242	16140	305	16444
	1972	94	7.3	184	9745	0	10049
	1973	115	8.5	218	11876	305	11876
	1974	101	4.3	163	6090	0	6395
	1975	115	3.9	189	5177	305	5481
	1976	64	1.9	65	2436	0	2741
	1977	58	0.8	62	1218	0	1218
	1978	109	10.4	322	12485	305	12790
	1979	67	4.0	126	5786	0	5786
	1980	55	6.9	155	9440	0	9440
	1981	68	1.9	82	2436	0	2436
	1982	88	3.8	230	5177	0	5177
	1983	73	3.3	78	4568	0	4568
	1984	91	11.5	396	15226	305	15531
	1985	81	4.0	139	5786	0	5786
	1986	74	7.6	206	10658	305	10658

## E.2 Unit Area Loading

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
BARON	1962	101	5.6	3.6	0.34	0.00	0.35
	1963	70	6.2	6.7	0.38	0.00	0.39
	1964	106	9.0	7.3	0.55	0.00	0.56
	1965	115	9.6	10.4	0.57	0.01	0.57
	1966	98	10.8	7.8	0.37	0.00	0.38
	1967	126	11.1	8.4	0.67	0.01	0.67
	1968	140	13.2	9.1	0.77	0.01	0.78
	1969	122	13.2	10.3	0.75	0.01	0.76
	1970	155	27.3	19.0	1.65	0.01	1.67
	1971	118	11.5	6.6	0.68	0.01	0.69
	1972	110	12.5	6.3	0.78	0.01	0.79
	1973	207	29.5	18.3	1.66	0.01	1.67
	1974	157	23.3	15.5	1.40	0.01	1.41
	1975	134	5.0	3.5	0.29	0.00	0.29
	1976	115	4.1	3.7	0.20	0.00	0.20
	1977	106	9.9	8.0	0.44	0.00	0.44
	1978	111	8.7	6.0	0.48	0.00	0.48
	1979	115	8.3	7.0	0.51	0.01	0.51
	1980	88	6.0	4.4	0.37	0.00	0.38
	1981	111	4.0	3.0	0.25	0.00	0.25
	1982	125	14.9	8.2	0.83	0.01	0.84
	1983	102	6.5	3.7	0.40	0.00	0.40
	1984	161	17.2	14.0	1.04	0.01	1.05
	1985	151	20.5	13.6	1.12	0.01	1.13
	1986	146	19.1	10.7	1.13	0.01	1.14
BBARON	1962	65	0.6	0.8	0.00	0.00	0.00
	1963	70	4.5	2.0	0.07	0.00	0.08
	1964	104	5.2	4.8	0.09	0.00	0.09
	1965	76	5.4	4.5	0.09	0.00	0.09
	1966	53	2.5	1.3	0.04	0.00	0.04
	1967	89	7.0	2.8	0.12	0.00	0.12
	1968	75	4.3	2.2	0.08	0.00	0.08
	1969	87	5.8	2.6	0.09	0.00	0.10
	1970	64	3.5	4.9	0.06	0.00	0.06
	1971	101	10.8	5.3	0.19	0.00	0.19
	1972	68	2.7	1.3	0.04	0.00	0.05
	1973	107	5.2	2.2	0.09	0.00	0.09
	1974	103	12.8	5.2	0.21	0.00	0.22
	1975	78	5.5	2.8	0.09	0.00	0.10
	1976	59	1.3	0.8	0.02	0.00	0.02
	1977	91	5.1	2.2	0.09	0.00	0.09
	1978	77	3.9	2.0	0.06	0.00	0.06
	1979	99	16.8	10.2	0.27	0.00	0.28
	1980	62	1.8	0.7	0.03	0.00	0.03
	1981	56	1.6	0.5	0.02	0.00	0.02
	1982	75	4.3	1.8	0.07	0.00	0.08
	1983	78	2.4	1.1	0.04	0.00	0.04
	1984	81	2.4	1.2	0.04	0.00	0.04
	1985	124	12.4	6.1	0.21	0.00	0.21
	1986	151	29.6	19.3	0.46	0.00	0.47

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
BENTON	1962	121	14.3	5.4	0.97	0	0.97
	1963	59	2.6	0.6	0.16	0	0.17
	1964	103	7.6	5.3	0.52	0	0.52
	1965	94	8.6	4.2	0.5	0	0.5
	1966	103	4.3	1.9	0.22	0	0.22
	1967	109	7.4	2.2	0.48	0	0.48
	1968	129	9.0	2.4	0.57	0	0.57
	1969	111	9.5	2.7	0.57	0	0.58
	1970	115	13.1	10.5	0.92	0	0.92
	1971	101	6.6	1.9	0.44	0	0.44
	1972	106	10.9	3.5	0.76	0	0.76
	1973	193	15.7	17.6	0.99	0	1
	1974	153	33.6	10.7	2.25	0.01	2.26
	1975	152	15.4	5.6	1.06	0	1.06
	1976	97	5.4	2.3	0.3	0	0.3
	1977	98	4.2	1.6	0.26	0	0.26
	1978	93	4.0	1.0	0.22	0	0.22
	1979	104	9.7	2.9	0.66	0	0.66
	1980	65	1.1	1.0	0.04	0	0.04
	1981	114	5.5	1.8	0.36	0	0.36
	1982	101	6.9	3.1	0.45	0	0.45
	1983	88	1.1	0.6	0.02	0	0.02
	1984	145	16.7	6.3	1.14	0.01	1.15
	1985	142	12.9	4.0	0.84	0	0.84
	1986	134	20.3	7.0	1.31	0.01	1.32
BILIN	1962	65	1.3	0.6	0.01	0	0.01
	1963	70	5.8	1.4	0.08	0	0.08
	1964	104	7.8	7.1	0.11	0	0.11
	1965	76	7.0	4.9	0.09	0	0.09
	1966	53	3.4	1.1	0.04	0	0.04
	1967	89	9.4	2.6	0.13	0	0.13
	1968	75	6.1	1.6	0.08	0	0.08
	1969	87	7.4	3.4	0.1	0	0.1
	1970	64	4.8	4.6	0.06	0	0.06
	1971	101	14.4	3.8	0.2	0	0.2
	1972	68	4.0	3.6	0.05	0	0.05
	1973	107	7.7	1.5	0.1	0	0.1
	1974	103	16.0	5.9	0.22	0	0.22
	1975	78	7.5	3.8	0.1	0	0.1
	1976	59	2.0	3.0	0.02	0	0.02
	1977	91	7.2	4.4	0.1	0	0.1
	1978	77	5.1	1.7	0.06	0	0.06
	1979	99	19.6	8.3	0.26	0	0.27
	1980	62	2.7	0.7	0.03	0	0.03
	1981	56	2.4	0.6	0.03	0	0.03
	1982	75	6.2	3.5	0.08	0	0.08
	1983	78	3.5	0.9	0.04	0	0.04
	1984	81	3.8	1.0	0.04	0	0.04
	1985	124	15.9	5.0	0.22	0	0.22
	1986	151	34.1	12.0	0.44	0	0.45

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
BORD	1962	102	4.5	4.4	0.07	0	0.07
	1963	60	0.5	0.6	0	0	0
	1964	100	5.7	3.7	0.09	0	0.1
	1965	88	4.5	3.4	0.07	0	0.07
	1966	91	2.8	2.8	0.04	0	0.04
	1967	113	7.9	6.3	0.13	0	0.14
	1968	129	4.8	4.5	0.07	0	0.07
	1969	108	4.5	2.8	0.07	0	0.07
	1970	126	14.4	8.8	0.23	0	0.23
	1971	104	3.7	2.5	0.06	0	0.07
	1972	109	11.4	7.7	0.19	0	0.19
	1973	208	21.9	16.0	0.33	0.01	0.34
	1974	155	24.0	16.4	0.37	0.01	0.38
	1975	136	6.4	7.3	0.1	0	0.11
	1976	101	6.0	3.3	0.08	0	0.08
	1977	127	8.8	6.7	0.14	0	0.14
	1978	108	6.9	7.7	0.11	0	0.11
	1979	99	3.9	6.0	0.06	0	0.06
	1980	61	1.6	1.1	0.02	0	0.02
	1981	119	8.0	5.8	0.12	0	0.13
	1982	89	4.1	15.6	0.06	0	0.06
	1983	98	3.1	16.3	0.04	0	0.05
	1984	126	7.0	4.6	0.12	0	0.12
	1985	183	17.7	12.8	0.28	0.01	0.29
	1986	142	27.8	26.6	0.38	0.01	0.39
CANEY	1962	89	9.8	18.9	0.19	0	0.2
	1963	105	5.1	7.0	0.09	0	0.1
	1964	85	8.8	9.3	0.18	0	0.18
	1965	87	6.2	6.3	0.12	0	0.12
	1966	67	0.8	2.4	0.01	0	0.01
	1967	89	4.1	9.3	0.08	0	0.09
	1968	60	4.8	6.1	0.09	0	0.1
	1969	80	8.3	9.6	0.17	0	0.18
	1970	63	2.3	3.7	0.04	0	0.04
	1971	126	12.4	12.4	0.26	0.01	0.26
	1972	94	7.8	9.9	0.15	0	0.16
	1973	115	9.1	10.8	0.18	0.01	0.19
	1974	101	4.8	7.8	0.1	0	0.1
	1975	115	4.5	8.9	0.09	0	0.09
	1976	64	2.2	2.8	0.04	0	0.04
	1977	58	1.1	2.6	0.02	0	0.02
	1978	109	10.9	16.9	0.21	0.01	0.22
	1979	67	4.4	6.6	0.09	0	0.09
	1980	55	7.2	8.0	0.15	0	0.15
	1981	68	2.3	4.1	0.04	0	0.04
	1982	88	4.3	8.7	0.08	0	0.08
	1983	73	3.7	4.1	0.07	0	0.07
	1984	91	11.9	21.0	0.24	0.01	0.25
	1985	81	4.4	7.0	0.09	0	0.09
	1986	74	8.0	9.9	0.17	0	0.17

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
CLEAR	1962	122	13.6	8.0	1.34	0	1.35
	1963	55	3.4	2.0	0.33	0	0.33
	1964	92	7.4	4.8	0.72	0	0.73
	1965	101	6.7	2.9	0.62	0	0.62
	1966	95	8.6	7.0	0.54	0	0.54
	1967	98	8.1	5.6	0.78	0	0.79
	1968	124	6.6	6.9	0.59	0	0.6
	1969	112	16.9	8.1	1.48	0	1.49
	1970	106	9.0	4.4	0.88	0	0.88
	1971	89	4.9	3.5	0.45	0	0.45
	1972	104	15.8	8.6	1.57	0.01	1.58
	1973	165	14.6	11.5	1.42	0.01	1.42
	1974	134	17.7	8.5	1.67	0.01	1.67
	1975	124	7.0	9.3	0.62	0	0.62
	1976	79	3.5	3.1	0.25	0	0.25
	1977	103	5.5	4.1	0.46	0	0.46
	1978	109	10.5	6.3	0.97	0	0.98
	1979	95	2.0	2.1	0.14	0	0.14
	1980	71	2.6	1.9	0.24	0	0.24
	1981	114	6.4	3.8	0.61	0	0.61
	1982	138	30.2	19.5	2.92	0.01	2.93
	1983	91	4.0	1.6	0.36	0	0.37
	1984	127	7.2	9.8	0.68	0	0.68
	1985	135	15.2	8.5	1.38	0	1.39
	1986	133	20.7	11.4	2.01	0.01	2.02
FLINT	1962	102	6.8	12.8	0.40	0.01	0.41
	1963	60	0.9	2.2	0.01	0.00	0.01
	1964	100	8.8	10.0	0.56	0.00	0.56
	1965	88	6.8	8.8	0.42	0.00	0.42
	1966	91	4.7	7.5	0.26	0.00	0.26
	1967	113	11.5	13.4	0.77	0.01	0.78
	1968	129	8.0	12.9	0.41	0.01	0.42
	1969	108	6.8	7.9	0.40	0.00	0.41
	1970	126	19.0	19.6	1.31	0.01	1.32
	1971	104	6.2	7.6	0.38	0.00	0.39
	1972	109	15.7	16.0	1.08	0.01	1.09
	1973	208	29.6	38.3	1.88	0.02	1.89
	1974	155	30.6	29.2	2.12	0.01	2.13
	1975	136	9.8	21.3	0.62	0.01	0.63
	1976	101	8.5	6.9	0.46	0.00	0.46
	1977	127	12.5	19.0	0.81	0.01	0.82
	1978	108	10.0	10.4	0.60	0.00	0.61
	1979	99	5.6	9.3	0.33	0.00	0.34
	1980	61	2.6	3.5	0.14	0.00	0.15
	1981	119	10.8	13.8	0.71	0.01	0.72
	1982	89	6.2	14.1	0.35	0.00	0.36
	1983	98	4.8	15.2	0.26	0.00	0.26
	1984	126	10.4	13.1	0.69	0.01	0.70
	1985	183	24.8	30.1	1.65	0.01	1.67
	1986	142	32.2	70.5	2.12	0.02	2.14

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
FORK	1962	122	15.1	3.3	1.19	0	1.19
	1963	55	3.9	0.7	0.3	0	0.3
	1964	92	8.4	2.1	0.64	0	0.65
	1965	101	7.6	1.3	0.55	0	0.55
	1966	95	9.6	2.9	0.48	0	0.48
	1967	98	9.1	4.0	0.7	0	0.7
	1968	124	7.8	3.0	0.54	0	0.54
	1969	112	18.9	2.9	1.32	0	1.32
	1970	106	10.4	1.6	0.79	0	0.79
	1971	89	5.4	0.9	0.39	0	0.39
	1972	104	17.3	3.7	1.38	0	1.38
	1973	166	16.6	4.0	1.26	0	1.26
	1974	134	19.8	3.6	1.48	0	1.48
	1975	124	8.1	4.1	0.55	0	0.56
	1976	79	4.0	1.6	0.22	0	0.22
	1977	103	6.4	2.0	0.41	0	0.41
	1978	109	11.8	2.3	0.87	0	0.87
	1979	95	2.5	1.3	0.13	0	0.13
	1980	71	3.1	1.4	0.21	0	0.22
LAKE	1981	114	7.4	1.5	0.54	0	0.55
	1982	138	32.5	8.6	2.54	0	2.55
	1983	91	4.6	0.7	0.33	0	0.33
	1984	127	8.4	8.3	0.61	0	0.61
	1985	135	17.0	4.1	1.23	0	1.23
	1986	133	22.6	4.8	1.76	0	1.76
LAKE	1962	78	15.2	1.1	0.02	0	0.02
	1963	50	8.8	0.3	0.01	0	0.01
	1964	83	16.1	1.4	0.02	0	0.02
	1965	80	13.6	0.9	0.01	0	0.01
	1966	62	9.5	0.2	0	0	0
	1967	84	14.3	1.9	0.01	0	0.01
	1968	89	16.6	1.2	0.02	0	0.02
	1969	87	20.0	2.6	0.03	0	0.03
	1970	70	13.6	1.4	0.02	0	0.02
	1971	93	20.5	2.1	0.03	0	0.03
	1972	91	21.2	1.9	0.04	0	0.04
	1973	124	24.7	2.1	0.03	0	0.03
	1974	128	37.5	5.9	0.08	0	0.08
	1975	101	17.8	5.7	0.01	0	0.01
	1976	73	15.4	2.0	0.02	0	0.02
	1977	95	18.8	1.1	0.02	0	0.02
	1978	76	13.4	0.6	0.01	0	0.01
	1979	102	23.2	2.5	0.04	0	0.04
	1980	74	13.7	0.8	0.01	0	0.01
	1981	84	15.5	1.0	0.01	0	0.01
	1982	91	17.9	3.2	0.02	0	0.02
	1983	102	25.6	6.7	0.05	0	0.05
	1984	98	17.0	3.9	0.01	0	0.01
	1985	168	50.8	7.3	0.12	0	0.12
	1986	143	47.3	6.1	0.12	0	0.12

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
LAKEUP	1962	65	1.0	0.8	0.01	0	0.01
	1963	69	6.6	1.5	0.07	0	0.07
	1964	103	9.4	3.9	0.1	0	0.10
	1965	76	7.9	3.4	0.08	0	0.08
	1966	53	3.7	1.2	0.04	0	0.04
	1967	88	11.3	3.0	0.12	0	0.12
	1968	75	7.3	1.6	0.08	0	0.08
	1969	86	8.2	3.5	0.08	0	0.09
	1970	64	5.6	4.0	0.05	0	0.05
	1971	101	17.8	4.7	0.18	0	0.18
	1972	68	4.5	2.2	0.05	0	0.05
	1973	106	9.3	1.6	0.09	0	0.09
	1974	103	18.9	4.4	0.19	0	0.19
	1975	78	9.0	3.7	0.09	0	0.09
	1976	59	1.9	8.8	0.02	0	0.02
	1977	91	8.5	3.6	0.09	0	0.09
	1978	76	5.5	1.7	0.06	0	0.06
	1979	98	22.5	11.1	0.23	0	0.23
	1980	62	3.0	0.7	0.03	0	0.03
	1981	56	2.5	0.7	0.03	0	0.03
	1982	74	7.4	2.6	0.08	0	0.08
	1983	78	3.5	0.7	0.04	0	0.04
	1984	81	4.3	1.2	0.04	0	0.04
	1985	124	19.0	12.8	0.19	0	0.19
	1986	151	38.9	9.5	0.38	0	0.38
OSAGE	1962	120	7.6	18.3	0.59	0	0.59
	1963	57	1.1	1.2	0.03	0	0.03
	1964	95	7.5	5.2	0.55	0	0.55
	1965	114	11.6	5.7	0.76	0	0.76
	1966	85	4.7	5.5	0.27	0	0.28
	1967	93	5.9	5.6	0.43	0	0.44
	1968	143	11.8	9.5	0.84	0	0.84
	1969	114	8.8	6.3	0.65	0	0.65
	1970	125	11.8	12.9	0.99	0	1
	1971	102	6.4	4.2	0.5	0	0.5
	1972	98	8.4	3.9	0.7	0	0.7
	1973	184	15.9	12.4	1.25	0.01	1.26
	1974	122	20.6	9.6	1.84	0.01	1.85
	1975	145	17.4	17.3	1.41	0.01	1.42
	1976	90	6.4	4.2	0.48	0	0.49
	1977	98	5.0	9.2	0.36	0	0.36
	1978	105	6.5	11.4	0.47	0	0.47
	1979	108	10.5	6.8	0.85	0	0.86
	1980	73	3.7	2.4	0.27	0	0.27
	1981	110	3.9	6.0	0.23	0	0.24
	1982	102	9.2	8.6	0.75	0	0.75
	1983	92	1.9	4.7	0.06	0	0.06
	1984	137	12.3	10.4	0.96	0.01	0.96
	1985	152	19.6	14.4	1.5	0.01	1.51
	1986	134	22.6	15.3	1.85	0.01	1.86

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
RIVER	1962	101	5.4	2.7	0.11	0	0.12
	1963	60	0.5	0.6	0	0	0
	1964	99	7.0	2.6	0.16	0	0.16
	1965	88	5.5	2.0	0.12	0	0.12
	1966	91	3.5	2.0	0.07	0	0.07
	1967	113	9.5	4.3	0.21	0	0.22
	1968	129	6.0	2.9	0.12	0	0.12
	1969	108	5.3	1.8	0.11	0	0.11
	1970	125	16.5	6.2	0.36	0	0.37
	1971	104	4.7	1.9	0.11	0	0.11
	1972	109	13.4	5.1	0.3	0	0.3
	1973	208	25.4	10.7	0.53	0.01	0.54
	1974	155	27.1	12.7	0.59	0.01	0.59
	1975	136	7.8	5.3	0.17	0	0.18
	1976	101	7.0	2.1	0.14	0	0.14
	1977	127	10.4	4.3	0.23	0	0.23
	1978	108	8.2	6.0	0.17	0	0.18
	1979	99	4.5	4.9	0.09	0	0.09
	1980	60	1.9	0.8	0.04	0	0.04
	1981	119	9.1	3.7	0.2	0	0.2
	1982	89	5.0	14.7	0.1	0	0.1
	1983	98	3.7	14.5	0.07	0	0.07
	1984	126	8.4	3.0	0.19	0	0.19
	1985	182	21.0	8.7	0.46	0.01	0.47
	1986	142	29.9	19.5	0.59	0.01	0.6
TYNER	1962	101	4.6	5.4	0.16	0	0.16
	1963	60	0.1	0.7	0	0	0
	1964	99	6.2	5.3	0.22	0	0.22
	1965	88	4.7	4.5	0.16	0	0.17
	1966	91	2.7	4.1	0.1	0	0.1
	1967	113	8.5	8.7	0.29	0.01	0.3
	1968	128	4.9	6.1	0.17	0.01	0.17
	1969	108	4.5	4.1	0.15	0	0.16
	1970	125	15.5	12.4	0.5	0.01	0.51
	1971	104	3.8	3.8	0.14	0	0.15
	1972	109	12.5	11.1	0.42	0.01	0.42
	1973	207	23.6	21.9	0.74	0.01	0.75
	1974	155	25.9	23.4	0.81	0.01	0.82
	1975	136	6.6	10.8	0.23	0.01	0.24
	1976	101	6.2	4.8	0.19	0	0.2
	1977	127	9.4	9.4	0.31	0.01	0.32
	1978	108	7.3	13.5	0.24	0	0.25
	1979	99	3.8	11.2	0.13	0	0.13
	1980	60	1.5	1.5	0.05	0	0.06
	1981	119	8.2	7.9	0.27	0	0.28
	1982	89	4.2	33.4	0.14	0	0.14
	1983	98	2.9	33.2	0.1	0	0.1
	1984	126	7.4	6.9	0.26	0.01	0.26
	1985	182	19.4	18.8	0.64	0.01	0.65
	1986	142	28.9	38.6	0.83	0.01	0.85

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
WEST	1962	89	9.4	22.1	0.4	0.01	0.41
	1963	105	4.5	4.3	0.18	0	0.19
	1964	85	8.4	6.0	0.37	0	0.38
	1965	87	5.7	4.1	0.25	0	0.26
	1966	67	0.5	2.5	0.02	0	0.02
	1967	89	3.6	3.5	0.18	0	0.18
	1968	60	4.5	3.7	0.19	0	0.2
	1969	80	7.9	6.3	0.36	0.01	0.36
	1970	63	2.0	3.0	0.09	0	0.09
	1971	126	11.8	8.0	0.53	0.01	0.54
	1972	94	7.3	6.1	0.32	0	0.33
	1973	115	8.5	7.2	0.39	0.01	0.39
	1974	101	4.3	5.3	0.2	0	0.21
	1975	115	3.9	6.2	0.17	0.01	0.18
	1976	64	1.9	2.1	0.08	0	0.09
	1977	58	0.8	2.1	0.04	0	0.04
	1978	109	10.4	10.6	0.41	0.01	0.42
	1979	67	4.0	4.1	0.19	0	0.19
	1980	55	6.9	5.1	0.31	0	0.31
	1981	68	1.9	2.7	0.08	0	0.08
	1982	88	3.8	7.6	0.17	0	0.17
	1983	73	3.3	2.6	0.15	0	0.15
	1984	91	11.5	13.0	0.5	0.01	0.51
	1985	81	4.0	4.6	0.19	0	0.19
	1986	74	7.6	6.8	0.35	0.01	0.35

**APPENDIX F**  
**SIMPLE OUTPUT BY SUB-BASIN AND YEAR USING CONTINUOUS SIMULATION MODE**

**F.1 Mass Loading**

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
BARON	1962	101	5.6	141	13333	0	13725
	1963	70	6.2	264	21960	392	22352
	1964	106	9.0	287	41959	392	42351
	1965	115	9.6	408	54115	392	54507
	1966	98	10.8	306	60782	392	61174
	1967	126	11.1	328	86271	784	86663
	1968	140	13.2	356	114505	784	115289
	1969	122	13.2	403	122348	784	123132
	1970	155	27.3	743	275282	1569	276851
	1971	118	11.5	260	121563	784	122348
	1972	110	12.5	245	145092	784	146268
	1973	207	29.5	716	350181	1961	352142
	1974	157	23.3	609	284694	1569	286262
	1975	134	5.0	138	61174	392	61566
	1976	115	4.1	147	52939	392	53723
	1977	106	9.9	313	138818	784	139602
	1978	111	8.7	236	134112	784	134896
	1979	115	8.3	273	134896	784	136073
	1980	88	6.0	173	101956	784	102741
	1981	111	4.0	118	70585	392	71369
	1982	125	14.9	322	278812	1569	280380
	1983	102	6.5	146	124308	784	125093
	1984	161	17.2	549	343123	1961	345083
	1985	151	20.5	534	399983	1961	402336
	1986	146	19.1	419	375670	1569	377239
BBARON	1962	65	0.6	10	0	0	0
	1963	70	4.5	25	1171	0	1171
	1964	104	5.2	63	1561	0	1561
	1965	76	5.4	59	1691	0	1691
	1966	53	2.5	17	781	0	781
	1967	89	7.0	37	2732	0	2732
	1968	75	4.3	28	1821	0	1821
	1969	87	5.8	33	2342	0	2342
	1970	64	3.5	63	1561	0	1561
	1971	101	10.8	68	5464	0	5464
	1972	68	2.7	17	1301	0	1301
	1973	107	5.2	29	2732	0	2862
	1974	103	12.8	68	6895	0	6895
	1975	78	5.5	36	3122	0	3122
	1976	59	1.3	10	650	0	650
	1977	91	5.1	29	3252	0	3252
	1978	77	3.9	25	2212	0	2342
	1979	99	16.8	132	10407	130	10537
	1980	62	1.8	9	1041	0	1171
	1981	56	1.6	7	911	0	1041
	1982	75	4.3	23	3252	0	3252
	1983	78	2.4	15	1561	0	1561
	1984	81	2.4	16	1821	0	1821
	1985	124	12.4	79	9757	130	9887
	1986	151	29.6	251	21075	130	20814

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
BENTON	1962	121	14.3	204	36484	0	36484
	1963	59	2.6	23	7899	0	7899
	1964	103	7.6	199	30842	0	31218
	1965	94	8.6	159	38740	0	38740
	1966	103	4.3	71	19934	0	19934
	1967	109	7.4	83	45511	0	45511
	1968	129	9.0	91	61308	376	61684
	1969	111	9.5	100	68078	376	68454
	1970	115	13.1	395	110579	376	110955
	1971	101	6.6	72	56418	376	56418
	1972	106	10.9	131	103809	376	104185
	1973	193	15.7	662	153457	376	153833
	1974	153	33.6	402	338884	1128	339636
	1975	152	15.4	210	157970	376	158347
	1976	97	5.4	85	51528	376	51528
	1977	98	4.2	60	42125	0	42125
	1978	93	4.0	39	42125	0	42502
	1979	104	9.7	109	119982	376	120358
	1980	65	1.1	36	7146	0	7146
	1981	114	5.5	69	71463	376	71839
	1982	101	6.9	116	98920	376	99296
	1983	88	1.1	22	4137	0	4513
	1984	145	16.7	238	262156	752	263284
	1985	142	12.9	149	204985	752	205738
	1986	134	20.3	261	320454	1128	321206
BILIN	1962	65	1.3	6	102	0	102
	1963	70	5.8	14	914	0	914
	1964	104	7.8	72	1320	0	1320
	1965	76	7.0	49	1219	0	1219
	1966	53	3.4	11	609	0	609
	1967	89	9.4	26	2031	0	2031
	1968	75	6.1	16	1320	0	1422
	1969	87	7.4	35	1625	0	1625
	1970	64	4.8	47	1117	0	1117
	1971	101	14.4	38	3859	0	3960
	1972	68	4.0	37	1016	0	1016
	1973	107	7.7	15	2133	0	2133
	1974	103	16.0	60	4671	0	4671
	1975	78	7.5	38	2234	0	2234
	1976	59	2.0	30	508	0	508
	1977	91	7.2	45	2234	0	2336
	1978	77	5.1	17	1523	0	1523
	1979	99	19.6	84	6601	0	6601
	1980	62	2.7	7	812	0	812
	1981	56	2.4	6	711	0	711
	1982	75	6.2	35	2234	0	2234
	1983	78	3.5	9	1117	0	1117
	1984	81	3.8	10	1320	0	1320
	1985	124	15.9	51	6398	0	6499
	1986	151	34.1	122	12897	102	12998

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
BORD	1962	102	4.5	145	2309	0	2309
	1963	60	0.5	18	0	0	0
	1964	100	5.7	122	4949	0	4949
	1965	88	4.5	112	4289	0	4289
	1966	91	2.8	93	2969	0	2969
	1967	113	7.9	208	9898	330	9898
	1968	129	4.8	147	6268	0	6598
	1969	108	4.5	94	6268	0	6268
	1970	126	14.4	290	21445	330	21775
	1971	104	3.7	83	6268	0	6268
	1972	109	11.4	254	19795	330	20125
	1973	208	21.9	527	36621	660	37281
	1974	155	24.0	542	39260	660	39590
	1975	136	6.4	240	11217	330	11547
	1976	101	6.0	108	10228	0	10228
	1977	127	8.8	220	16826	330	17156
	1978	108	6.9	255	13527	330	13857
	1979	99	3.9	197	7258	0	7258
	1980	61	1.6	37	3299	0	3299
	1981	119	8.0	191	17486	330	17486
	1982	89	4.1	515	9898	0	9898
	1983	98	3.1	538	6928	0	7258
	1984	126	7.0	151	18476	330	18805
	1985	183	17.7	424	47179	660	48168
	1986	142	27.8	879	59386	990	60375
CANEY	1962	89	9.8	594	5975	0	6289
	1963	105	5.1	220	3774	0	3774
	1964	85	8.8	292	8176	314	8176
	1965	87	6.2	199	6289	0	6604
	1966	67	0.8	76	629	0	629
	1967	89	4.1	292	5660	0	5660
	1968	60	4.8	191	6918	0	6918
	1969	80	8.3	303	13837	314	14151
	1970	63	2.3	116	3774	0	3774
	1971	126	12.4	390	23900	314	24214
	1972	94	7.8	310	14780	314	15095
	1973	115	9.1	340	18868	314	19183
	1974	101	4.8	245	10378	314	10692
	1975	115	4.5	280	10063	314	10378
	1976	64	2.2	88	4717	0	5032
	1977	58	1.1	82	2201	0	2516
	1978	109	10.9	530	29875	629	30504
	1979	67	4.4	208	12264	314	12579
	1980	55	7.2	251	20441	314	20755
	1981	68	2.3	128	6289	314	6604
	1982	88	4.3	272	12264	314	12579
	1983	73	3.7	130	11321	314	11321
	1984	91	11.9	660	38365	629	38994
	1985	81	4.4	221	14780	314	15095
	1986	74	8.0	310	27673	314	28302

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
CLEAR	1962	122	13.6	167	28002	0	28211
	1963	55	3.4	41	9195	0	9195
	1964	92	7.4	99	25912	0	26121
	1965	101	6.7	61	27166	0	27166
	1966	95	8.6	146	35734	209	35943
	1967	98	8.1	118	45138	209	45138
	1968	124	6.6	143	39704	209	39704
	1969	112	16.9	170	115560	209	115769
	1970	106	9.0	91	67288	209	67497
	1971	89	4.9	73	36152	0	36361
	1972	104	15.8	180	138547	209	138965
	1973	165	14.6	240	131651	418	132069
	1974	134	17.7	177	168639	209	168848
	1975	124	7.0	194	65408	209	65617
	1976	79	3.5	64	31972	0	31972
	1977	103	5.5	86	57258	209	57467
	1978	109	10.5	131	122456	209	122874
	1979	95	2.0	43	17553	209	17762
	1980	71	2.6	40	30510	0	30719
	1981	114	6.4	80	82961	209	83170
	1982	138	30.2	408	421492	836	422119
	1983	91	4.0	34	50780	0	50780
	1984	127	7.2	205	100097	209	100306
	1985	135	15.2	177	225061	418	225479
	1986	133	20.7	238	310947	627	311574
FLINT	1962	102	6.8	412	12844	321	13165
	1963	60	0.9	70	321	0	321
	1964	100	8.8	319	31146	321	31467
	1965	88	6.8	282	27935	321	28256
	1966	91	4.7	240	19908	321	20229
	1967	113	11.5	429	66466	642	67108
	1968	129	8.0	415	43989	642	44632
	1969	108	6.8	254	42384	321	43026
	1970	126	19.0	631	148344	963	148986
	1971	104	6.2	245	45595	321	45916
	1972	109	15.7	514	139674	963	140637
	1973	208	29.6	1230	264578	1605	265863
	1974	155	30.6	937	284165	1284	285449
	1975	136	9.8	683	84768	642	85410
	1976	101	8.5	221	75777	321	76098
	1977	127	12.5	608	125867	963	126831
	1978	108	10.0	335	103070	642	103391
	1979	99	5.6	300	54264	321	54585
	1980	61	2.6	112	25045	321	25045
	1981	119	10.8	441	130363	963	131005
	1982	89	6.2	454	74493	321	74814
	1983	98	4.8	486	53622	642	53943
	1984	126	10.4	421	142564	963	143527
	1985	183	24.8	966	363474	1927	365400
	1986	142	32.2	2263	452416	2248	454663

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
FORK	1962	122	15.1	137	49345	0	49345
	1963	55	3.9	30	16586	0	16586
	1964	92	8.4	85	45613	0	45613
	1965	101	7.6	56	47271	0	47271
	1966	95	9.6	118	62199	0	62199
	1967	98	9.1	166	78371	0	78785
	1968	124	7.8	123	70492	0	70492
	1969	112	18.9	118	200281	415	200695
	1970	106	10.4	66	117763	0	118178
	1971	89	5.4	37	62199	0	62199
	1972	104	17.3	152	237186	415	237600
	1973	166	16.6	164	228478	415	228892
	1974	134	19.8	150	290262	415	290677
	1975	124	8.1	170	114446	415	114446
	1976	79	4.0	65	55150	0	55150
	1977	103	6.4	82	99933	0	100348
	1978	109	11.8	95	211062	415	211477
	1979	95	2.5	55	31929	0	31929
	1980	71	3.1	56	53906	0	53906
	1981	114	7.4	64	144302	415	144716
	1982	138	32.5	355	710313	829	711142
	1983	91	4.6	29	87493	0	87493
	1984	127	8.4	344	174157	415	174572
	1985	135	17.0	170	384390	415	384804
	1986	133	22.6	199	524545	415	525374
LAKE	1962	78	15.2	38	680	0	680
	1963	50	8.8	11	340	0	340
	1964	83	16.1	46	680	0	1021
	1965	80	13.6	32	340	0	340
	1966	62	9.5	8	0	0	0
	1967	84	14.3	64	680	0	680
	1968	89	16.6	40	1021	0	1021
	1969	87	20.0	87	2721	0	2721
	1970	70	13.6	47	1361	0	1361
	1971	93	20.5	72	2721	0	2721
	1972	91	21.2	63	3402	0	3402
	1973	124	24.7	73	2721	0	3062
	1974	128	37.5	200	8164	0	8504
	1975	101	17.8	193	1361	0	1361
	1976	73	15.4	67	2381	0	2381
	1977	95	18.8	36	2381	0	2381
	1978	76	13.4	20	1021	0	1021
	1979	102	23.2	86	4422	0	4762
	1980	74	13.7	27	1701	0	1701
	1981	84	15.5	32	2041	0	2041
	1982	91	17.9	109	2721	0	2721
	1983	102	25.6	229	6123	0	6123
	1984	98	17.0	132	1701	0	1701
	1985	168	50.8	247	17009	0	17009
	1986	143	47.3	209	15988	0	15988

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
LAKEUP	1962	65	1.0	4	54	0	54
	1963	69	6.6	8	430	0	430
	1964	103	9.4	21	753	0	753
	1965	76	7.9	18	700	0	700
	1966	53	3.7	7	377	0	377
	1967	88	11.3	16	1238	0	1238
	1968	75	7.3	9	861	0	861
	1969	86	8.2	19	1022	0	1022
	1970	64	5.6	22	753	0	753
	1971	101	17.8	25	2637	0	2637
	1972	68	4.5	12	700	0	700
	1973	106	9.3	9	1507	0	1507
	1974	103	18.9	24	3175	0	3175
	1975	78	9.0	20	1560	0	1560
	1976	59	1.9	47	323	0	323
	1977	91	8.5	19	1668	0	1668
	1978	76	5.5	9	1076	0	1130
	1979	98	22.5	60	4574	0	4574
	1980	62	3.0	4	646	0	646
	1981	56	2.5	4	538	0	538
	1982	74	7.4	14	1722	0	1722
	1983	78	3.5	4	807	0	807
	1984	81	4.3	6	1022	0	1022
	1985	124	19.0	69	4789	0	4789
	1986	151	38.9	51	9202	0	9255
OSAGE	1962	120	7.6	1052	33837	0	33837
	1963	57	1.1	67	2294	0	2294
	1964	95	7.5	298	57350	574	57924
	1965	114	11.6	329	105524	574	106098
	1966	85	4.7	317	44733	0	44733
	1967	93	5.9	323	71114	574	71688
	1968	143	11.8	547	165168	574	165742
	1969	114	8.8	361	134773	574	135346
	1970	125	11.8	740	212195	574	212769
	1971	102	6.4	243	114127	574	114700
	1972	98	8.4	226	172624	574	173197
	1973	184	15.9	708	339512	1147	340659
	1974	122	20.6	553	508695	1147	509842
	1975	145	17.4	993	420376	1721	422096
	1976	90	6.4	243	149110	574	149110
	1977	98	5.0	525	111259	574	111833
	1978	105	6.5	654	163448	574	163448
	1979	108	10.5	391	305676	1147	306823
	1980	73	3.7	137	96922	574	97495
	1981	110	3.9	341	86599	574	87172
	1982	102	9.2	494	302808	1147	303955
	1983	92	1.9	270	22940	574	23514
	1984	137	12.3	596	432419	1721	434140
	1985	152	19.6	826	734080	1721	735801
	1986	134	22.6	875	875161	1721	876308

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
RIVER	1962	101	5.4	34	1382	0	1508
	1963	60	0.5	7	0	0	0
	1964	99	7.0	32	2764	0	2889
	1965	88	5.5	25	2387	0	2387
	1966	91	3.5	24	1633	0	1633
	1967	113	9.5	54	5276	0	5276
	1968	129	6.0	36	3518	0	3518
	1969	108	5.3	23	3266	0	3266
	1970	125	16.5	77	11055	0	11055
	1971	104	4.7	24	3392	0	3392
	1972	109	13.4	63	10050	126	10176
	1973	208	25.4	134	18845	126	18970
	1974	155	27.1	159	19850	126	19975
	1975	136	7.8	67	5905	0	6030
	1976	101	7.0	27	5276	0	5276
	1977	127	10.4	54	8543	0	8668
	1978	108	8.2	75	7035	0	7035
	1979	99	4.5	62	3643	0	3643
	1980	60	1.9	10	1633	0	1633
	1981	119	9.1	47	8668	0	8794
	1982	89	5.0	184	5025	0	5025
	1983	98	3.7	182	3643	0	3643
	1984	126	8.4	38	9422	0	9548
	1985	182	21.0	109	23870	126	23995
	1986	142	29.9	244	29146	126	29272
TYNER	1962	101	4.6	59	1743	0	1743
	1963	60	0.1	7	0	0	0
	1964	99	6.2	57	3050	0	3159
	1965	88	4.7	49	2506	0	2615
	1966	91	2.7	45	1634	0	1743
	1967	113	8.5	95	5447	109	5556
	1968	128	4.9	66	3377	109	3486
	1969	108	4.5	44	3159	109	3268
	1970	125	15.5	135	11003	109	11112
	1971	104	3.8	41	3159	0	3268
	1972	109	12.5	121	9805	109	10022
	1973	207	23.6	238	18084	218	18302
	1974	155	25.9	255	19065	218	19282
	1975	136	6.6	118	5447	109	5556
	1976	101	6.2	52	4902	109	4902
	1977	127	9.4	102	7953	109	8062
	1978	108	7.3	147	6427	109	6536
	1979	99	3.8	122	3377	0	3377
	1980	60	1.5	17	1525	0	1525
	1981	119	8.2	86	7953	109	8062
	1982	89	4.2	364	4467	109	4467
	1983	98	2.9	362	3159	109	3268
	1984	126	7.4	75	8497	109	8606
	1985	182	19.4	205	21461	327	21788
	1986	142	28.9	420	26799	327	27126

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (Mg)	Soluble Phosphorus (kg)	Sediment-bound Phosphorus (kg)	Total Phosphorus (kg)
WEST	1962	89	9.4	674	12181	305	12485
	1963	105	4.5	129	7918	0	7918
	1964	85	8.4	184	19489	305	19489
	1965	87	5.7	125	15531	305	15835
	1966	67	0.5	75	1523	0	1523
	1967	89	3.6	107	14617	305	14921
	1968	60	4.5	113	18576	305	18576
	1969	80	7.9	190	37151	305	37760
	1970	63	2.0	92	10049	0	10049
	1971	126	11.8	242	65776	609	66385
	1972	94	7.3	184	41415	305	42024
	1973	115	8.5	218	52682	609	53291
	1974	101	4.3	163	28929	305	29538
	1975	115	3.9	189	28016	609	28625
	1976	64	1.9	65	13399	305	13703
	1977	58	0.8	62	6395	305	6395
	1978	109	10.4	322	86179	914	87093
	1979	67	4.0	126	35933	305	36238
	1980	55	6.9	155	59686	609	60295
	1981	68	1.9	82	18271	305	18576
	1982	88	3.8	230	35933	305	36238
	1983	73	3.3	78	32888	305	33497
	1984	91	11.5	396	113586	1218	114804
	1985	81	4.0	139	42937	609	43546
	1986	74	7.6	206	82525	914	83134

## F.2 Unit Area Loading

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
BARON	1962	101	5.6	3.6	0.34	0.00	0.35
	1963	70	6.2	6.7	0.56	0.01	0.57
	1964	106	9.0	7.3	1.07	0.01	1.08
	1965	115	9.6	10.4	1.38	0.01	1.39
	1966	98	10.8	7.8	1.55	0.01	1.56
	1967	126	11.1	8.4	2.20	0.02	2.21
	1968	140	13.2	9.1	2.92	0.02	2.94
	1969	122	13.2	10.3	3.12	0.02	3.14
	1970	155	27.3	19.0	7.02	0.04	7.06
	1971	118	11.5	6.6	3.10	0.02	3.12
	1972	110	12.5	6.3	3.70	0.02	3.73
	1973	207	29.5	18.3	8.93	0.05	8.98
	1974	157	23.3	15.5	7.26	0.04	7.30
	1975	134	5.0	3.5	1.56	0.01	1.57
	1976	115	4.1	3.7	1.35	0.01	1.37
	1977	106	9.9	8.0	3.54	0.02	3.56
	1978	111	8.7	6.0	3.42	0.02	3.44
	1979	115	8.3	7.0	3.44	0.02	3.47
	1980	88	6.0	4.4	2.60	0.02	2.62
	1981	111	4.0	3.0	1.80	0.01	1.82
	1982	125	14.9	8.2	7.11	0.04	7.15
	1983	102	6.5	3.7	3.17	0.02	3.19
	1984	161	17.2	14.0	8.75	0.05	8.80
	1985	151	20.5	13.6	10.20	0.05	10.26
	1986	146	19.1	10.7	9.58	0.04	9.62
BBARON	1962	65	0.6	0.8	0.00	0.00	0.00
	1963	70	4.5	2.0	0.09	0.00	0.09
	1964	104	5.2	4.8	0.12	0.00	0.12
	1965	76	5.4	4.5	0.13	0.00	0.13
	1966	53	2.5	1.3	0.06	0.00	0.06
	1967	89	7.0	2.8	0.21	0.00	0.21
	1968	75	4.3	2.2	0.14	0.00	0.14
	1969	87	5.8	2.6	0.18	0.00	0.18
	1970	64	3.5	4.9	0.12	0.00	0.12
	1971	101	10.8	5.3	0.42	0.00	0.42
	1972	68	2.7	1.3	0.10	0.00	0.10
	1973	107	5.2	2.2	0.21	0.00	0.22
	1974	103	12.8	5.2	0.53	0.00	0.53
	1975	78	5.5	2.8	0.24	0.00	0.24
	1976	59	1.3	0.8	0.05	0.00	0.05
	1977	91	5.1	2.2	0.25	0.00	0.25
	1978	77	3.9	2.0	0.17	0.00	0.18
	1979	99	16.8	10.2	0.80	0.01	0.81
	1980	62	1.8	0.7	0.08	0.00	0.09
	1981	56	1.6	0.5	0.07	0.00	0.08
	1982	75	4.3	1.8	0.25	0.00	0.25
	1983	78	2.4	1.1	0.12	0.00	0.12
	1984	81	2.4	1.2	0.14	0.00	0.14
	1985	124	12.4	6.1	0.75	0.01	0.76
	1986	151	29.6	19.3	1.62	0.01	1.60

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
BENTON	1962	121	14.3	5.4	0.97	0	0.97
	1963	59	2.6	0.6	0.21	0	0.21
	1964	103	7.6	5.3	0.82	0	0.83
	1965	94	8.6	4.2	1.03	0	1.03
	1966	103	4.3	1.9	0.53	0	0.53
	1967	109	7.4	2.2	1.21	0	1.21
	1968	129	9.0	2.4	1.63	0.01	1.64
	1969	111	9.5	2.7	1.81	0.01	1.82
	1970	115	13.1	10.5	2.94	0.01	2.95
	1971	101	6.6	1.9	1.5	0.01	1.5
	1972	106	10.9	3.5	2.76	0.01	2.77
	1973	193	15.7	17.6	4.08	0.01	4.09
	1974	153	33.6	10.7	9.01	0.03	9.03
	1975	152	15.4	5.6	4.2	0.01	4.21
	1976	97	5.4	2.3	1.37	0.01	1.37
	1977	98	4.2	1.6	1.12	0	1.12
	1978	93	4.0	1.0	1.12	0	1.13
	1979	104	9.7	2.9	3.19	0.01	3.2
	1980	65	1.1	1.0	0.19	0	0.19
BILIN	1981	114	5.5	1.8	1.9	0.01	1.91
	1982	101	6.9	3.1	2.63	0.01	2.64
	1983	88	1.1	0.6	0.11	0	0.12
	1984	145	16.7	6.3	6.97	0.02	7
	1985	142	12.9	4.0	5.45	0.02	5.47
	1986	134	20.3	7.0	8.52	0.03	8.54
	1962	65	1.3	0.6	0.01	0	0.01
	1963	70	5.8	1.4	0.09	0	0.09
	1964	104	7.8	7.1	0.13	0	0.13
	1965	76	7.0	4.9	0.12	0	0.12
	1966	53	3.4	1.1	0.06	0	0.06
	1967	89	9.4	2.6	0.2	0	0.2
	1968	75	6.1	1.6	0.13	0	0.14
	1969	87	7.4	3.4	0.16	0	0.16
	1970	64	4.8	4.6	0.11	0	0.11
	1971	101	14.4	3.8	0.38	0	0.39
	1972	68	4.0	3.6	0.1	0	0.1
	1973	107	7.7	1.5	0.21	0	0.21
	1974	103	16.0	5.9	0.46	0	0.46
	1975	78	7.5	3.8	0.22	0	0.22
	1976	59	2.0	3.0	0.05	0	0.05
	1977	91	7.2	4.4	0.22	0	0.23
	1978	77	5.1	1.7	0.15	0	0.15
	1979	99	19.6	8.3	0.65	0	0.65
	1980	62	2.7	0.7	0.08	0	0.08
	1981	56	2.4	0.6	0.07	0	0.07
	1982	75	6.2	3.5	0.22	0	0.22
	1983	78	3.5	0.9	0.11	0	0.11
	1984	81	3.8	1.0	0.13	0	0.13
	1985	124	15.9	5.0	0.63	0	0.64
	1986	151	34.1	12.0	1.27	0.01	1.28

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
BORD	1962	102	4.5	4.4	0.07	0	0.07
	1963	60	0.5	0.6	0	0	0
	1964	100	5.7	3.7	0.15	0	0.15
	1965	88	4.5	3.4	0.13	0	0.13
	1966	91	2.8	2.8	0.09	0	0.09
	1967	113	7.9	6.3	0.3	0.01	0.3
	1968	129	4.8	4.5	0.19	0	0.2
	1969	108	4.5	2.8	0.19	0	0.19
	1970	126	14.4	8.8	0.65	0.01	0.66
	1971	104	3.7	2.5	0.19	0	0.19
	1972	109	11.4	7.7	0.6	0.01	0.61
	1973	208	21.9	16.0	1.11	0.02	1.13
	1974	155	24.0	16.4	1.19	0.02	1.2
	1975	136	6.4	7.3	0.34	0.01	0.35
	1976	101	6.0	3.3	0.31	0	0.31
	1977	127	8.8	6.7	0.51	0.01	0.52
	1978	108	6.9	7.7	0.41	0.01	0.42
	1979	99	3.9	6.0	0.22	0	0.22
	1980	61	1.6	1.1	0.1	0	0.1
	1981	119	8.0	5.8	0.53	0.01	0.53
	1982	89	4.1	15.6	0.3	0	0.3
	1983	98	3.1	16.3	0.21	0	0.22
	1984	126	7.0	4.6	0.56	0.01	0.57
	1985	183	17.7	12.8	1.43	0.02	1.46
	1986	142	27.8	26.6	1.8	0.03	1.83
CANEY	1962	89	9.8	18.9	0.19	0	0.2
	1963	105	5.1	7.0	0.12	0	0.12
	1964	85	8.8	9.3	0.26	0.01	0.26
	1965	87	6.2	6.3	0.2	0	0.21
	1966	67	0.8	2.4	0.02	0	0.02
	1967	89	4.1	9.3	0.18	0	0.18
	1968	60	4.8	6.1	0.22	0	0.22
	1969	80	8.3	9.6	0.44	0.01	0.45
	1970	63	2.3	3.7	0.12	0	0.12
	1971	126	12.4	12.4	0.76	0.01	0.77
	1972	94	7.8	9.9	0.47	0.01	0.48
	1973	115	9.1	10.8	0.6	0.01	0.61
	1974	101	4.8	7.8	0.33	0.01	0.34
	1975	115	4.5	8.9	0.32	0.01	0.33
	1976	64	2.2	2.8	0.15	0	0.16
	1977	58	1.1	2.6	0.07	0	0.08
	1978	109	10.9	16.9	0.95	0.02	0.97
	1979	67	4.4	6.6	0.39	0.01	0.4
	1980	55	7.2	8.0	0.65	0.01	0.66
	1981	68	2.3	4.1	0.2	0.01	0.21
	1982	88	4.3	8.7	0.39	0.01	0.4
	1983	73	3.7	4.1	0.36	0.01	0.36
	1984	91	11.9	21.0	1.22	0.02	1.24
	1985	81	4.4	7.0	0.47	0.01	0.48
	1986	74	8.0	9.9	0.88	0.01	0.9

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
CLEAR	1962	122	13.6	8.0	1.34	0	1.35
	1963	55	3.4	2.0	0.44	0	0.44
	1964	92	7.4	4.8	1.24	0	1.25
	1965	101	6.7	2.9	1.3	0	1.3
	1966	95	8.6	7.0	1.71	0.01	1.72
	1967	98	8.1	5.6	2.16	0.01	2.16
	1968	124	6.6	6.9	1.9	0.01	1.9
	1969	112	16.9	8.1	5.53	0.01	5.54
	1970	106	9.0	4.4	3.22	0.01	3.23
	1971	89	4.9	3.5	1.73	0	1.74
	1972	104	15.8	8.6	6.63	0.01	6.65
	1973	165	14.6	11.5	6.3	0.02	6.32
	1974	134	17.7	8.5	8.07	0.01	8.08
	1975	124	7.0	9.3	3.13	0.01	3.14
	1976	79	3.5	3.1	1.53	0	1.53
	1977	103	5.5	4.1	2.74	0.01	2.75
	1978	109	10.5	6.3	5.86	0.01	5.88
	1979	95	2.0	2.1	0.84	0.01	0.85
	1980	71	2.6	1.9	1.46	0	1.47
	1981	114	6.4	3.8	3.97	0.01	3.98
	1982	138	30.2	19.5	20.17	0.04	20.2
	1983	91	4.0	1.6	2.43	0	2.43
	1984	127	7.2	9.8	4.79	0.01	4.8
	1985	135	15.2	8.5	10.77	0.02	10.79
	1986	133	20.7	11.4	14.88	0.03	14.91
FLINT	1962	102	6.8	12.8	0.40	0.01	0.41
	1963	60	0.9	2.2	0.01	0.00	0.01
	1964	100	8.8	10.0	0.97	0.01	0.98
	1965	88	6.8	8.8	0.87	0.01	0.88
	1966	91	4.7	7.5	0.62	0.01	0.63
	1967	113	11.5	13.4	2.07	0.02	2.09
	1968	129	8.0	12.9	1.37	0.02	1.39
	1969	108	6.8	7.9	1.32	0.01	1.34
	1970	126	19.0	19.6	4.62	0.03	4.64
	1971	104	6.2	7.6	1.42	0.01	1.43
	1972	109	15.7	16.0	4.35	0.03	4.38
	1973	208	29.6	38.3	8.24	0.05	8.28
	1974	155	30.6	29.2	8.85	0.04	8.89
	1975	136	9.8	21.3	2.64	0.02	2.66
	1976	101	8.5	6.9	2.36	0.01	2.37
	1977	127	12.5	19.0	3.92	0.03	3.95
	1978	108	10.0	10.4	3.21	0.02	3.22
	1979	99	5.6	9.3	1.69	0.01	1.70
	1980	61	2.6	3.5	0.78	0.01	0.78
	1981	119	10.8	13.8	4.06	0.03	4.08
	1982	89	6.2	14.1	2.32	0.01	2.33
	1983	98	4.8	15.2	1.67	0.02	1.68
	1984	126	10.4	13.1	4.44	0.03	4.47
	1985	183	24.8	30.1	11.32	0.06	11.38
	1986	142	32.2	70.5	14.09	0.07	14.16

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
FORK	1962	122	15.1	3.3	1.19	0	1.19
	1963	55	3.9	0.7	0.4	0	0.4
	1964	92	8.4	2.1	1.1	0	1.1
	1965	101	7.6	1.3	1.14	0	1.14
	1966	95	9.6	2.9	1.5	0	1.5
	1967	98	9.1	4.0	1.89	0	1.9
	1968	124	7.8	3.0	1.7	0	1.7
	1969	112	18.9	2.9	4.83	0.01	4.84
	1970	106	10.4	1.6	2.84	0	2.85
	1971	89	5.4	0.9	1.5	0	1.5
	1972	104	17.3	3.7	5.72	0.01	5.73
	1973	166	16.6	4.0	5.51	0.01	5.52
	1974	134	19.8	3.6	7	0.01	7.01
	1975	124	8.1	4.1	2.76	0.01	2.76
	1976	79	4.0	1.6	1.33	0	1.33
	1977	103	6.4	2.0	2.41	0	2.42
	1978	109	11.8	2.3	5.09	0.01	5.1
	1979	95	2.5	1.3	0.77	0	0.77
	1980	71	3.1	1.4	1.3	0	1.3
	1981	114	7.4	1.5	3.48	0.01	3.49
	1982	138	32.5	8.6	17.13	0.02	17.15
	1983	91	4.6	0.7	2.11	0	2.11
	1984	127	8.4	8.3	4.2	0.01	4.21
	1985	135	17.0	4.1	9.27	0.01	9.28
	1986	133	22.6	4.8	12.65	0.01	12.67
LAKE	1962	78	15.2	1.1	0.02	0	0.02
	1963	50	8.8	0.3	0.01	0	0.01
	1964	83	16.1	1.4	0.02	0	0.03
	1965	80	13.6	0.9	0.01	0	0.01
	1966	62	9.5	0.2	0	0	0
	1967	84	14.3	1.9	0.02	0	0.02
	1968	89	16.6	1.2	0.03	0	0.03
	1969	87	20.0	2.6	0.08	0	0.08
	1970	70	13.6	1.4	0.04	0	0.04
	1971	93	20.5	2.1	0.08	0	0.08
	1972	91	21.2	1.9	0.1	0	0.1
	1973	124	24.7	2.1	0.08	0	0.09
	1974	128	37.5	5.9	0.24	0	0.25
	1975	101	17.8	5.7	0.04	0	0.04
	1976	73	15.4	2.0	0.07	0	0.07
	1977	95	18.8	1.1	0.07	0	0.07
	1978	76	13.4	0.6	0.03	0	0.03
	1979	102	23.2	2.5	0.13	0	0.14
	1980	74	13.7	0.8	0.05	0	0.05
	1981	84	15.5	1.0	0.06	0	0.06
	1982	91	17.9	3.2	0.08	0	0.08
	1983	102	25.6	6.7	0.18	0	0.18
	1984	98	17.0	3.9	0.05	0	0.05
	1985	168	50.8	7.3	0.5	0	0.5
	1986	143	47.3	6.1	0.47	0	0.47

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
LAKEUP	1962	65	1.0	0.8	0.01	0	0.01
	1963	69	6.6	1.5	0.08	0	0.08
	1964	103	9.4	3.9	0.14	0	0.14
	1965	76	7.9	3.4	0.13	0	0.13
	1966	53	3.7	1.2	0.07	0	0.07
	1967	88	11.3	3.0	0.23	0	0.23
	1968	75	7.3	1.6	0.16	0	0.16
	1969	86	8.2	3.5	0.19	0	0.19
	1970	64	5.6	4.0	0.14	0	0.14
	1971	101	17.8	4.7	0.49	0	0.49
	1972	68	4.5	2.2	0.13	0	0.13
	1973	106	9.3	1.6	0.28	0	0.28
	1974	103	18.9	4.4	0.59	0	0.59
	1975	78	9.0	3.7	0.29	0	0.29
	1976	59	1.9	8.8	0.06	0	0.06
	1977	91	8.5	3.6	0.31	0	0.31
	1978	76	5.5	1.7	0.2	0	0.21
	1979	98	22.5	11.1	0.85	0	0.85
	1980	62	3.0	0.7	0.12	0	0.12
	1981	56	2.5	0.7	0.1	0	0.1
	1982	74	7.4	2.6	0.32	0	0.32
	1983	78	3.5	0.7	0.15	0	0.15
	1984	81	4.3	1.2	0.19	0	0.19
	1985	124	19.0	12.8	0.89	0	0.89
	1986	151	38.9	9.5	1.71	0	1.72
OSAGE	1962	120	7.6	18.3	0.59	0	0.59
	1963	57	1.1	1.2	0.04	0	0.04
	1964	95	7.5	5.2	1	0.01	1.01
	1965	114	11.6	5.7	1.84	0.01	1.85
	1966	85	4.7	5.5	0.78	0	0.78
	1967	93	5.9	5.6	1.24	0.01	1.25
	1968	143	11.8	9.5	2.88	0.01	2.89
	1969	114	8.8	6.3	2.35	0.01	2.36
	1970	125	11.8	12.9	3.7	0.01	3.71
	1971	102	6.4	4.2	1.99	0.01	2
	1972	98	8.4	3.9	3.01	0.01	3.02
	1973	184	15.9	12.4	5.92	0.02	5.94
	1974	122	20.6	9.6	8.87	0.02	8.89
	1975	145	17.4	17.3	7.33	0.03	7.36
	1976	90	6.4	4.2	2.6	0.01	2.6
	1977	98	5.0	9.2	1.94	0.01	1.95
	1978	105	6.5	11.4	2.85	0.01	2.85
	1979	108	10.5	6.8	5.33	0.02	5.35
	1980	73	3.7	2.4	1.69	0.01	1.7
	1981	110	3.9	6.0	1.51	0.01	1.52
	1982	102	9.2	8.6	5.28	0.02	5.3
	1983	92	1.9	4.7	0.4	0.01	0.41
	1984	137	12.3	10.4	7.54	0.03	7.57
	1985	152	19.6	14.4	12.8	0.03	12.83
	1986	134	22.6	15.3	15.26	0.03	15.28

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
RIVER	1962	101	5.4	2.7	0.11	0	0.12
	1963	60	0.5	0.6	0	0	0
	1964	99	7.0	2.6	0.22	0	0.23
	1965	88	5.5	2.0	0.19	0	0.19
	1966	91	3.5	2.0	0.13	0	0.13
	1967	113	9.5	4.3	0.42	0	0.42
	1968	129	6.0	2.9	0.28	0	0.28
	1969	108	5.3	1.8	0.26	0	0.26
	1970	125	16.5	6.2	0.88	0	0.88
	1971	104	4.7	1.9	0.27	0	0.27
	1972	109	13.4	5.1	0.8	0.01	0.81
	1973	208	25.4	10.7	1.5	0.01	1.51
	1974	155	27.1	12.7	1.58	0.01	1.59
	1975	136	7.8	5.3	0.47	0	0.48
	1976	101	7.0	2.1	0.42	0	0.42
	1977	127	10.4	4.3	0.68	0	0.69
	1978	108	8.2	6.0	0.56	0	0.56
	1979	99	4.5	4.9	0.29	0	0.29
	1980	60	1.9	0.8	0.13	0	0.13
	1981	119	9.1	3.7	0.69	0	0.7
	1982	89	5.0	14.7	0.4	0	0.4
	1983	98	3.7	14.5	0.29	0	0.29
	1984	126	8.4	3.0	0.75	0	0.76
	1985	182	21.0	8.7	1.9	0.01	1.91
	1986	142	29.9	19.5	2.32	0.01	2.33
TYNER	1962	101	4.6	5.4	0.16	0	0.16
	1963	60	0.1	0.7	0	0	0
	1964	99	6.2	5.3	0.28	0	0.29
	1965	88	4.7	4.5	0.23	0	0.24
	1966	91	2.7	4.1	0.15	0	0.16
	1967	113	8.5	8.7	0.5	0.01	0.51
	1968	128	4.9	6.1	0.31	0.01	0.32
	1969	108	4.5	4.1	0.29	0.01	0.3
	1970	125	15.5	12.4	1.01	0.01	1.02
	1971	104	3.8	3.8	0.29	0	0.3
	1972	109	12.5	11.1	0.9	0.01	0.92
	1973	207	23.6	21.9	1.66	0.02	1.68
	1974	155	25.9	23.4	1.75	0.02	1.77
	1975	136	6.6	10.8	0.5	0.01	0.51
	1976	101	6.2	4.8	0.45	0.01	0.45
	1977	127	9.4	9.4	0.73	0.01	0.74
	1978	108	7.3	13.5	0.59	0.01	0.6
	1979	99	3.8	11.2	0.31	0	0.31
	1980	60	1.5	1.5	0.14	0	0.14
	1981	119	8.2	7.9	0.73	0.01	0.74
	1982	89	4.2	33.4	0.41	0.01	0.41
	1983	98	2.9	33.2	0.29	0.01	0.3
	1984	126	7.4	6.9	0.78	0.01	0.79
	1985	182	19.4	18.8	1.97	0.03	2
	1986	142	28.9	38.6	2.46	0.03	2.49

Watershed	Year	Rain Fall (cm)	Runoff (cm)	Sediment Yield (kg/ha)	Soluble Phosphorus (kg/ha)	Sediment-bound Phosphorus (kg/ha)	Total Phosphorus (kg/ha)
WEST	1962	89	9.4	22.1	0.4	0.01	0.41
	1963	105	4.5	4.3	0.26	0	0.26
	1964	85	8.4	6.0	0.64	0.01	0.64
	1965	87	5.7	4.1	0.51	0.01	0.52
	1966	67	0.5	2.5	0.05	0	0.05
	1967	89	3.6	3.5	0.48	0.01	0.49
	1968	60	4.5	3.7	0.61	0.01	0.61
	1969	80	7.9	6.3	1.22	0.01	1.24
	1970	63	2.0	3.0	0.33	0	0.33
	1971	126	11.8	8.0	2.16	0.02	2.18
	1972	94	7.3	6.1	1.36	0.01	1.38
	1973	115	8.5	7.2	1.73	0.02	1.75
	1974	101	4.3	5.3	0.95	0.01	0.97
	1975	115	3.9	6.2	0.92	0.02	0.94
	1976	64	1.9	2.1	0.44	0.01	0.45
	1977	58	0.8	2.1	0.21	0.01	0.21
	1978	109	10.4	10.6	2.83	0.03	2.86
	1979	67	4.0	4.1	1.18	0.01	1.19
	1980	55	6.9	5.1	1.96	0.02	1.98
	1981	68	1.9	2.7	0.6	0.01	0.61
	1982	88	3.8	7.6	1.18	0.01	1.19
	1983	73	3.3	2.6	1.08	0.01	1.1
	1984	91	11.5	13.0	3.73	0.04	3.77
	1985	81	4.0	4.6	1.41	0.02	1.43
	1986	74	7.6	6.8	2.71	0.03	2.73

**APPENDIX G**  
**SIMPLE LOADING BY STATE FOR INDEPENDENT SIMULATION MODE**

A. Percent Total Phosphorus Loading for Oklahoma and Arkansas by State

State	Total Phosphorus Loading (%)
Oklahoma	28
Arkansas	72

B. Sub-basin Total Phosphorus Loading by State

Watershed	Area (ha)		Total Phosphorus Load (kg/yr)	
	Oklahoma	Arkansas	Oklahoma	Arkansas
Flint	14577	17533	4595	19630
Baron	13661	25554	7921	19777
Benton	7725	29885	5410	18661